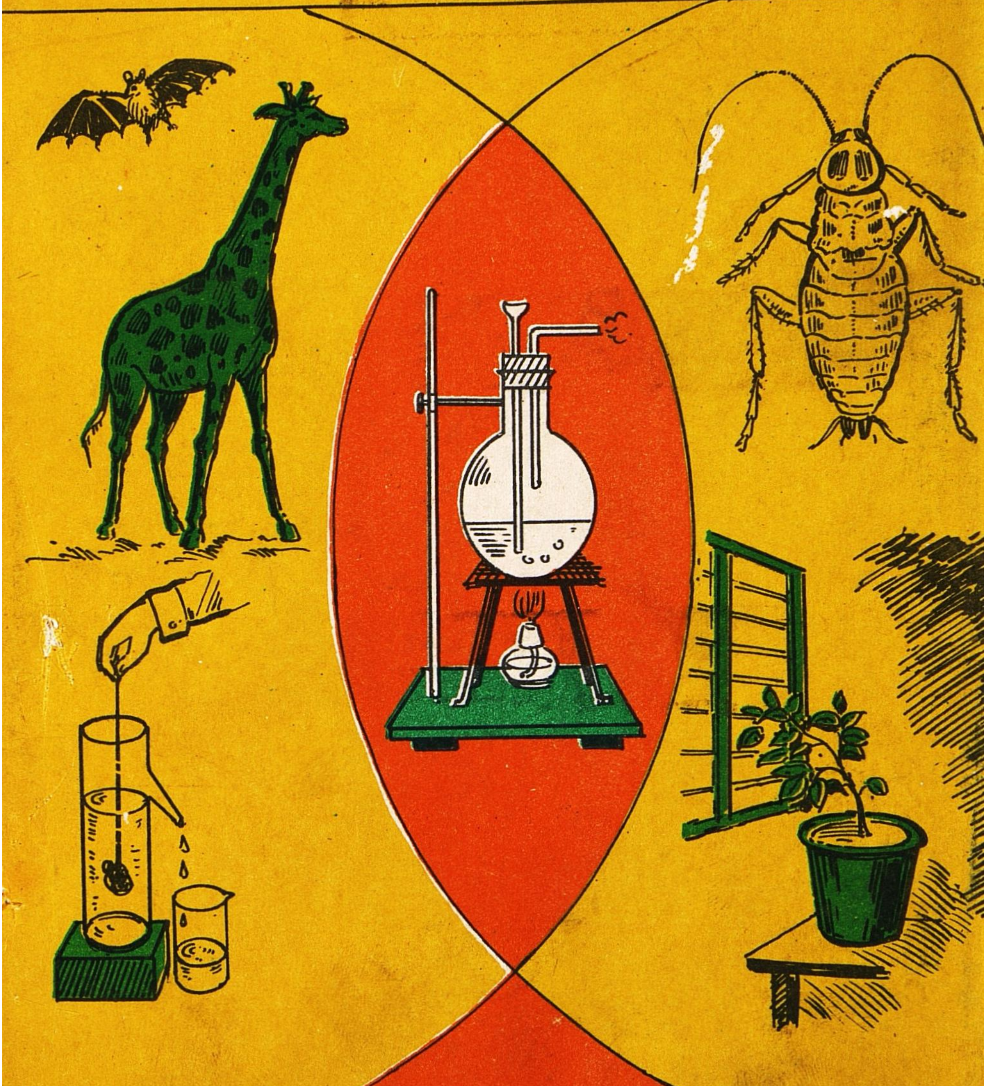
SCIENCE 6



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Authors:

Physics: Thiru. N.S. **Chidambaram,**
Science Assistant,
Dr. Guruswamy Mudaliar T.T.V. Higher Secondary School, Madras.

Chemistry: Thiru. **M. Jayaraman,**
Retd. Headmaster,
26, Ashok Avenue, Madras.

Biology: Tmt. **Neeta Hopper,**
Science Assistant,
Kalyanam Girls' Higher Secondary School, Madras.

Review Committee Members:

Physics: Thiru. **T.K. Sanjeevi,**
Headmaster,
W.P.A. Soundara Pandian Higher Secondary School,
Ayanavaram, Madras.

Chemistry: Thiru. **S. Mani,**
Headmaster,
Chintadripet Boys' Higher Secondary School, Chintadripet, Madras.

Biology: Thiru. **P.V. Srinivasan,**
Headmaster,
Government Higher Secondary School,
Pudupalayam,
North Arcot District.

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Part 1 PHYSICS

I. MECHANICS

1. FUNDAMENTAL MEASUREMENTS

Physics is the fundamental of all sciences. It is also called the Science of accurate measurements.

Importance of Measurement

It is sometimes said that 'Science is measurement.' Why?

If your mother asks your father to buy flowers, your father may ask "How much?" (Why?)

Cloth is necessary for stitching a pant or a shirt. If you go to a shop to buy cloth, the shop keeper may ask you how much you need. Why?

Thus measurements find an important place in the purchase of articles.

How did the method of measurement develop? Science advances with the following questions 'What?', 'How?' and 'Why?' If we add the question 'How much?' then the knowledge of Science is complete. Thus we realize that measurement is always associated with Science.

Science is meaningful if the properties of matter can be measured and compared with a standard measurement. So the systems of measurement and the accuracy of measuring instruments are important factors in the advancement of science.

Origin of Unit

First of all man used his hands and legs to measure things.

For example, he called the distance from the elbow to the tip of the middle finger of his hand as a cubit. Similarly he made some other measurements like span, palm length and digit. But there were many errors in these types of measurements. What are they?

Suppose your mother asks you to buy one cubit of flower, you go to the seller and ask for the flower. The seller measures one cubit of flower and gives it to you. If you measure it with your hand you would have got more flowers. Why? If your mother measures the same by her hand she would find the quantity less. Why?

On account of the variation in the length of our limbs the above mentioned types of measurements are not accurate.

Gradually, many changes were made to correct these types of errors. It was felt that a standard measurement was necessary to compare the numerical value of anything to be measured. That standard is known as the unit.

For the above reasons, different systems of measurements were used in different countries. To measure the length, the British used the fundamental unit 'Foot' whereas the French used 'Centimetre'. There was confusion because of the different types of measurements followed by various countries. How?

For example, the distance between any two towns in the above two countries is mentioned differently by the two countrymen. To get the conveyance charges they had to calculate the distance and they had to convert the units to their system of measurements. So problems and difficulties arose.

In order to clear these confusions, a new system has been devised.

System International

On 14th October, 1960 the International Conference of Weights and Measures was held in Paris. Scientists of all countries conferred and recommended a new system of measurement. The new system, which is a remodification of the Metric system is known as International System, (*SI*). The *SI* units are employed in all measurements and all the countries agreed to it.

Advantages of *SI*

1. The *SI* units are derived from the earlier *MKS* system, that is, the metric system. It is based on the decimel system, that is, they are multiples of ten.

2. Conversions of multiples into submultiples and vice versa are relatively simple.

3. Very minute measurements are possible.

Fundamental Units

All the measurements in Physics are related to the six chosen fundamental quantities. The six fundamental measurements and their respective units are tabulated below:

S.No.	Fundamental Measure ments	Fundamental Units
1.	Length	Metre (*m*)
2.	Mass	Kilogram (*kg*)
3.	Time	Second (*s*)
4.	Temperature	Kelvin (*k*)
5.	Electric Current	Ampere
6.	Luminous Intensity	Candala

QUESTIONS

(A) **Fill in the following blanks:**

1. Physics is the Science of ————————.
2. International System of measurement is known as ————————.
3. In *SI*, the units are based on the decimal system that are multiples of ————————.

(B) **Choose the correct answer from the following:**

SI is a remodification of the following system (a) British system (b) Metric system (c) Reamur system.

(C) **Match the following:**

Fundamental Measurements	Fundamental units
1. Length	(a) Kelvin
2. Mass	(b) Second
3. Time	(c) Metre
	(d) Ampere
	(e) Kilogram

(D) **Answer the following questions in one or two words:**

1. Name the units of limbs that were used by men in olden days.
2. Mention the units of length in the British and Metric systems.
3. What are the fundamental measurements?

(E) **Answer the following questions in one or two sentences:**

1. What is the importance of measurements?
2. What is a unit?
3. What are the advantages of the *SI* system?
4. Tabulate the fundamental measurements and their respective units.

2. MEASUREMENT OF LENGTH

What is length?

The fundamental measurement of length is the linear or curved distance, between any two points. In Fig. 1, *AB*,*CD*, and *EF* are called lengths.

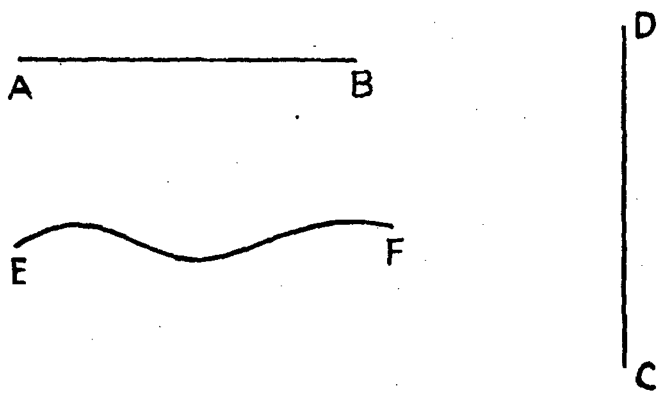


Fig. 1. Measuring the length

Breadth, height and diameter are also known as lengths. Refer to Fig. 2.

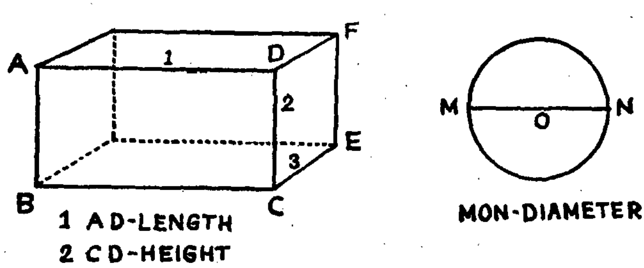


Fig. 2. Measuring the length

What types of measurements are the following? the distance between your school and the house; the distance between any two towns; the depth of the well.

Unit of Length

The unit of length in *SI* system is 'metre'.

The multiples of metre are decametre, hectametre and kilometre. The submultiples are decimetre, centimetre and millimetre.

What is the symbol used to denote length?

The fundamental unit of length is metre, This is represented by the symbol '*m*'. This symbol '*m*' *is* written after the numerical value of the length.

For example, the length of your class room is 7 metres. The numerical value '7' and the unit of length 'metre' (*m*) are written together. The length of the room is written as '7 *m*'.

A unit which is the multiple or submultiple of metre is to be converted into the unit 'metre'.

For example, the breadth of your book is 12 *cm*. You must write it not in *cm*. but in *m*. 100 *cm*. is equal to 1 *m*. So. 12 *cm*. is equal to 12/100 *m*, that is 0·12 *m*.

Look at the following tables.

1 kilometre	= 1000 metre	= 10^3 *m*.	
1 hectometre	= 100 metre	= 10^2 *m*.	
1 decametre	= 10 metre	= 10 *m*.	
1 decimetre	= 1/10 metre	= 10^{-1}*m*.	= 0·1 *m*.
1 centimetre	= 1/100 metre	= 10^{-2}*m*.	= 0·01 *m*.
1 millimetre	= 1/1000 metre	= 10^{-3}*m*.	= 0·001 *m*.

Scale

An instrument which is used to measure the length is a scale. Very often it is made of wood. (What are the materials used to make the scales now a days ?)

Generally a scale is graduated in centimetres and millimetres.

Observation: How many centimetres are marked in your scale? Into how many parts is a centimetre divided? What is the value of each part? Look at it and give the answers.

Method of Using a Scale

A scale is used to measure the length of objects. To avoid errors certain rules have to be followed while using a scale for measurement. What are they?

1. Since the scale is frequently used, the edges of the wooden scale will be worn out. So we must use any other marking from the edge for measurement.

(**Experiment:** For example, the length of a straight line is 5 *cm.* It is better to keep the scale on the straight line, the starting point being not the end of the scale but at the marking of 1 *cm.* or 2 *cm.* Now the other end shows 6 *cm.* or 7 *cm.* respectively. Therefore the length of the straight line = 6 *cm.* — 1 *cm.* = 5 *cm.* (or) 7 *cm.* — 2 *cm.* = 5 *cm.* respectively.)

2. Some scales may be thicker. While using that type of scale, the edge is held with the markings verti-

cally on paper along the line and the length is measured (Fig. 3).

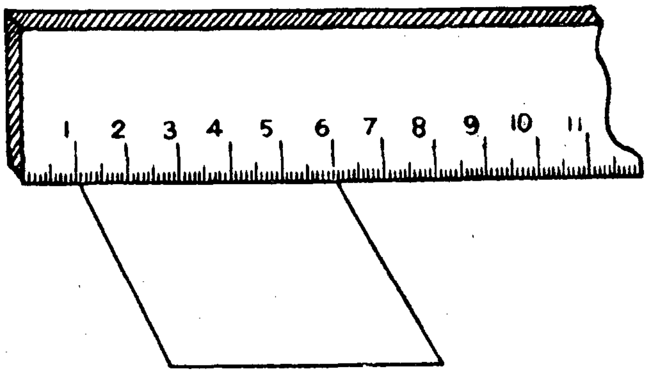


Fig. 3. Measuring with a scale

3. While the length is noted, the eye should be kept exactly perpendicular to the point used for measurement.

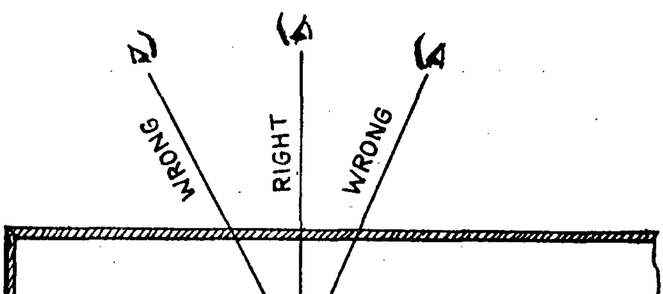


Fig. 4. Parallax error

urement. If the line of sight is slanted to either the left or the right, the measurement may either be more or less. This error is known as parallax error.

Measurement of the Length of a Curved Line

The following methods are used to measure the length of a curved line: (a) Thread method (b) Divider method (c) Opisometer.

(a) Thread Method

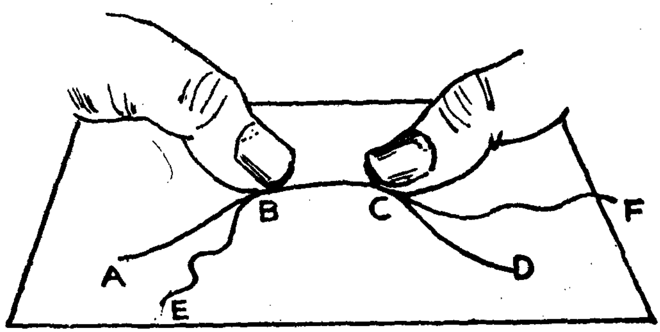


Fig. 5. Measuring with a thread
ABCD—Curved line EF—Thread

A thin inelastic thread is taken and a small ink mark is made near one end. That ink mark is kept exactly at one end *A* of the curved line. Gradually, the thread is made to lie exactly along the curved line. When it reaches the other end *D* another ink mark is made exactly over that point *D*. The length between these two ink marks on the thread can be measured with the help of a scale.

(b) Divider Method

A divider is taken and the distance between its limbs can be any small measurement (for example 4 *mm*). Then one limb of the divider is placed at the

starting point of the curved line. The two limbs of the divider run on the curved line. The number of steps taken all along the curve to reach the other end of the curved line are counted. If any small gap is left out at the other end, that gap is separately measured with the divider. Then the length of the curved line can be calculated as follows:

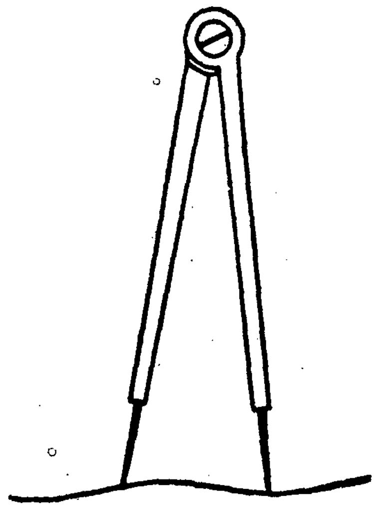


Fig. 6. Measuring with a divider

The length of the curved line = (Number of steps taken × the distance between the two limbs i.e. 4 *mm.*) + the length of remaining portion.

(c) Opisometer

This instrument is used to measure the length of curved lines of rivers and roads drawn on the maps.

It is a '⊔' shaped metal bar with its central axis constructed like a screw. A metal wheel with hard edges is fixed along its axis on this screw. It is capable of free rotation on the screw. One end of the metal bar has a sharp edge.

First of all the wheel is rotated and kept near the sharp edge. To keep it correctly there is a mark

on the wheel. This device is kept vertically at one end of the curved line and it is rotated slowly on it upto the other end. Now the wheel also moves away from the sharp point.

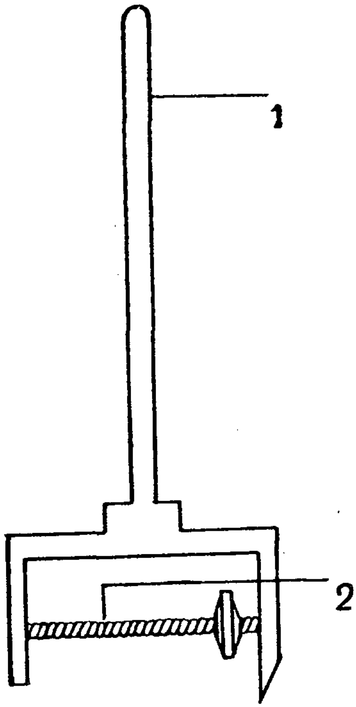


Fig. 7. Opisometer
1. Handle 2. Long screw

Then a long straight line is drawn on a white paper. Opisometer is now kept at one end of the straight line and the wheel is rotated in the opposite direction. When it reaches the sharp point, a point is marked on the straight line. This distance is measured by using a scale and this gives the length of the curved line.

To Measure the Diameter

How do we measure the diameter of spherical bodies like a ball or cylindrical objects?

The given sphere or cylinder is placed on a horizontal plane. On either side of the body two rectangular wooden blocks are kept. Their sides must be kept parellel without any movement. For this purpose another long rectangular wooden block may

be used. The breadth and height of wooden blocks must be larger than the diameter of the body.

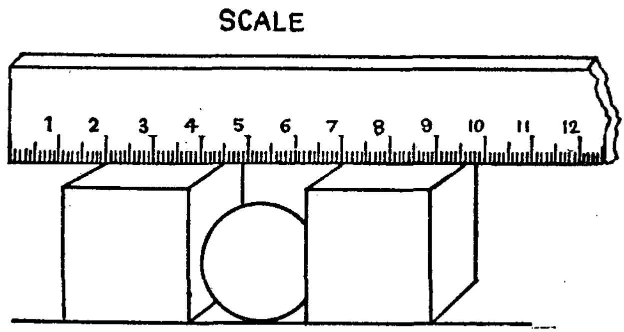


Fig. 8. Measuring the diameter

A scale is placed vertically on the wooden block which coincides with the upper edges of the blocks. The distance between the inner edges of the blocks is measured. It gives the diameter of the cylinder or the sphere.

To Measure the Diameter of a Circular Body

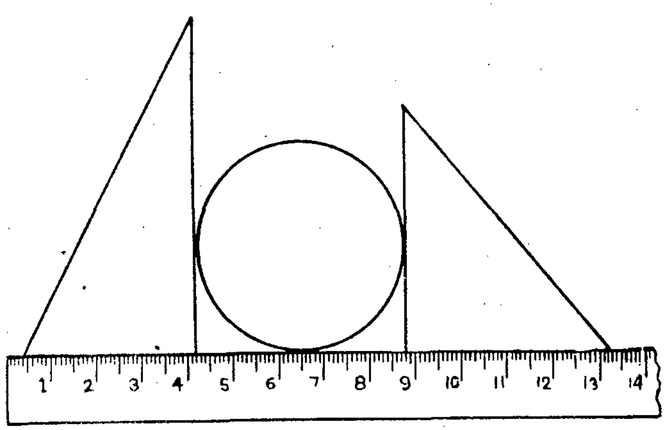


Fig. 9. Measuring the diameter of a circular body

To measure the diameter of a circular coin or other things two set squares are used as shown in the figure and it is measured by using a scale.

Circumference

Circumference is also a length. This length is considered a curved line of one rotation over a body.

To Measure the Circumference of a Cylinder

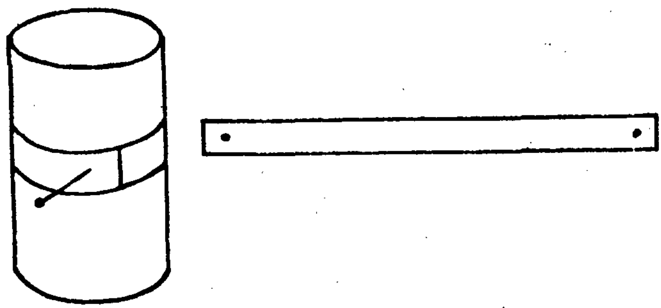


Fig. 10. Measuring the circumference of a cylinder

A long strip of paper is taken and it is wrapped closely round the cylinder. A pin is struck on the place where the strip overlaps. The pinprick is made through both the overlapping papers. Now the pin is taken out and the strip is straightened. The markings of the pinpricks are seen near the ends. The distance between the two pinpricks is measured. It is the circumference of the cylinder.

QUESTIONS

(A) Fill up the blanks in the following:

1. The unit of length in *SI* is ———— ————————.

2. The instrument that is used to measure the length is ——————————.

3. To measure the length of curved lines of rivers or rcads drawn on the maps, ———— —————————— is used.

4. A curved line which completes one rotation over a body is known as ——————.

(B) **Match the following:**

1.	10 *km.*	(a)	1 *m.*
2.	10 *hm.*	(b)	0·1 *m.*
3.	10 *dm.*	(c)	10000 *m.*
4.	10 *decim.*	(d)	0·01 *m.*
5.	10 *cm.*	(e)	1000 *m.*
6.	10 *mm.*	(f)	100 *m.*
		(g)	10 *m.*

(C) **Answer the following questions in one or two sentences:**

1. What is length?
2. What are the multiples of metre?
3. Mention the submultiples of metre.
4. Name the methods that are used to measure the length of curved lines.
5. What is circumference?

(D) **Answer the following questions in one or two sentences:**

1. What is meant by length?
2. How is the length denoted?
3. What is parallax error?

(E) Answer the following questions in detail:

1. How is a curved line measured by a thread?
2. Describe the divider method to measure the length of a curved line.
3. How do you measure the length of a river drawn on a map by using an opisometer?
4. Describe the method of finding the diameter of a sphere.
5. Describe a method to measure the diameter of a circular body.
6. Describe a method to measure the circumference of a cylinder.

PROBLEMS

1. Find the distance between your house and school in *km.* and *m.* approximately.
2. Calculate the following units in metre. (a) 2 *cm.* (b) 3 *mm.* (c) 5 *km.*
3. Convert 7·3107 *km.* into the following units: (a) in *cm.* (b) in decimetre (c) in decametre (d) in *mm.* (e) in *m.*

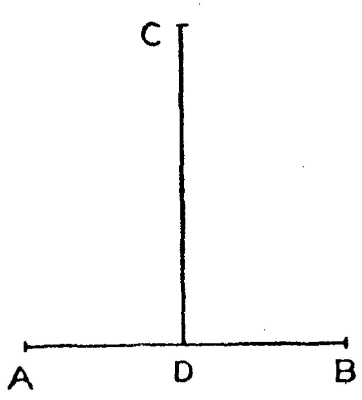


Fig. 11.

Exercise

1. Look at the figure. A line *CD* is drawn vertically to the centre of another line *AB*. Which line is longer? Measure the lengths of the two lines. Is your answer from observation correct?

2. The length of a river or a road drawn on a map is measured by an opisometer. But that is not the correct length. Why? There is a scale to measure the correct length. Try to learn it.

3. AREA

What is Area?

Take a fifty paise coin. Place the coin at the centre of a sheet of white paper on a table and draw its outline with a pencil. Remove the coin and place your geometrical instrument box and draw its outline. Replace the box with your science book and draw its outline. Then remove it.

The space of the coin is enclosed by a curved — circular — line. The spaces of the box and the book are enclosed by straight lines. The space enclosed by the circumference of the coin and the perimeters of the box and the book are called 'area', that is, the extent of the surface covered by a body is known as the area.

Unit of Area

Area is a derived measurement of length. Why?

To find the length of a straight line we must find the distance between the two end points of the straight line. One dimension is enough to measure the length. But to calculate the area, two lengths are needed.

In the *SI*, the fundamental unit of area is square metre. Why?

The unit of length is metre. Hence, the unit of area is metre × metre i.e. square metre. To denote this, we use the symbol 'm^2'.

So, to calculate the area, a length is multiplied by another length— that is breadth.

Like length, the multiples and submultiples of area also are converted into square metre (m^2). Look at the following table:

1 *mm*	× 1 *mm*	= 1 sq.mm.
i.e. 1/1000 *m.*	× 1/1000 *m.*	= 0·000001 sq.m.
i.e. 0·001 *m.*	× 0·001 *m.*	= 1×10^{-6} sq.m.
1 *cm.*	× 1 *cm.*	= 1 sq. cm.
i.e. 1/100 *m.*	× 1/100 *m.*	= 0·0001 sq.m.
i.e. 0·01 *m.*	× 0·01 *m.*	= 1×10^{-4} sq.m.
1 *dm.*	× 1 *dm.*	= 1 sq. dm.
i.e. 1/10 *m.*	× 1/10 *m.*	= 0·01 sq.m.
i.e. 0·1 *m.*	× 0·1 *m.*	= 1×10^{-2} sq.m.
1 *m.*	× 1 *m.*	= 1 sq. m.
i.e. 1 *deca m.*	× 1 *deca m.*	= 1 sq. deca m.
i.e. 10 *m.*	× 10 *m.*	= 100 sq.m. = 10^2 sq.m.
1 *hm.*	× 1 *hm.*	= 1 sq.hm.
i.e. 100 *m.*	× 100 *m.*	= 10000 sq.m. = 10^4 sq.m.
1 *km.*	× 1 *km.*	= 1 sq. km.
i.e. 1000 *m.*	× 1000 *m.*	= 1000000 sq.m. = 10^6 sq.m

Apart from the above units, Are and Hectare are the special units used to denote area.

100 sq.m. $= 10^2$ sq.m. $= 1$ Are.

10,000 sq.m. $= 10^4$ sq.m. $= 100$ Are $= 1$ Hectare.

Methods of Calculating Areas

For calculating the area, objects are classified into regular and irregular objects.

What are regular figures? Squares, Rectangles, Triangles, Circles etc., are some examples of regular figures. The area of these figures are calculated as follows:

(a) **Square**

It contains four equal sides. If its side is 'a' m, then its area $= a \times a = a^2$ sq.m.

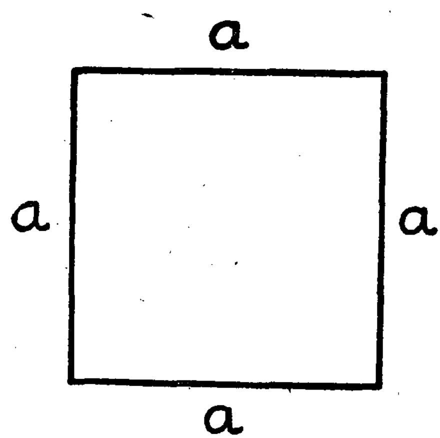


Fig. 12. Square

a—Side

(b) **Rectangle**

It consists of four straight lines, joined together to enclose the surface, that is, two equal lengths.

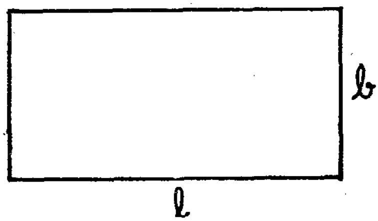


Fig. 13. Rectangle
l—length *b*—breadth

two equal breadths. If the length is '*l*' m. and breadth is '*b*' m., area of the rectangle = *lb* sq.m.

(c) **Triangle**

This is a figure enclosed by three straight lines. One side is the base. The height is the perpendicular line from the point (vertex), where the other two lines meet, to the base. If the base is '*b*' m. and the height is '*h*' m., the area of the triangle = $\frac{1}{2}$ *bh* sq.m.

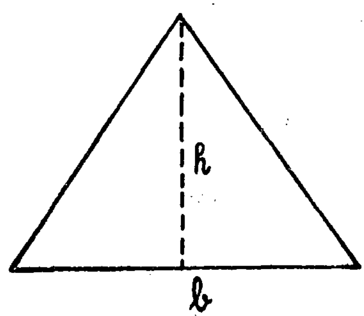


Fig. 14. Triangle
b—base *h*—height

(d) **Circle**

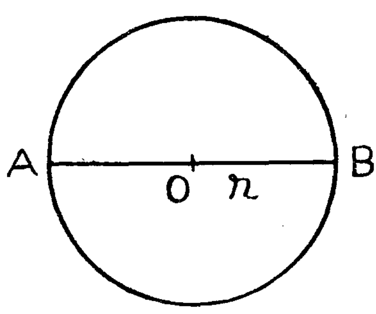


Fig. 15. Circle
OB—*r*—radius

It is a figure enclosed by a curved line. The straight line joining any two points in the above curved line (circumference) through its centre is known as the diameter. (In Fig. 15 *AOB*). Half of the diameter is radius (In figure *AO*

or *BO*). The area the circle of radius '*r*' m. = πr^2. The value of π (phi) is 22/7 or 3·14.

Thus formulae are used to calculate the areas of regular figures.

QUESTIONS

(A) Fill up the blanks in the following:

1. The space of a body enclosed by the line of circumference is its ——————————.
2. Area is the —————————— of length.
3. The fundamental unit of area is ————————————————————.
4. The figures are divided into two kinds: —————————— and ——————————.

(B) Match the following:

1.	1 Are	(a)	0·000001 sq.m.
2.	1 Sq.dm.	(b)	10000 sq.m.
3.	1 Sq. km.	(c)	100 sq.m.
4.	1 Hectare	(d)	1000000 sq.m.
5.	1 sq.mm.	(e)	0·01 sq.m.
		(f)	0·1 sq.m.

(C) Answer the following in one or two words:

1. How many dimensions are needed for calculating area?
2. Name the special units that are used to calculate the area.
3. Give examples for regular figures.

(D) Answer the question in one or two sentences:

1. How is the unit of area denoted?

(E) Answer the following:

1. Give the formulae to calculate the area of the following regular figures:

(a) Square (b) Rectangle (c) Circle (d) Triangle.

PROBLEMS

1. Convert the following units of area which are multiples and submultiples of square metre into its fundamental unit:

(a) 110 sq.cm. (b) 62500 sq.mm. (c) 0·14 sq. decim. (d) 0·03125 sq. km.

2. Calculate the area of the wrapper of your science book.

3. The length and breadth of your class room are 12 *m* and 9 *m*. respectively. What is its area?

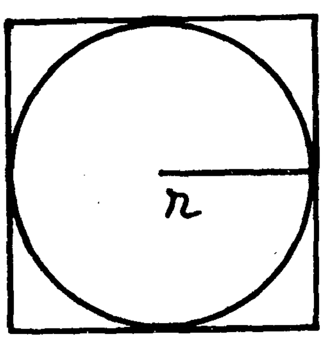


Fig. 16.

Name the two figures enclosed in the above diagram (Fig. 16). Calculate their areas.

Exercise

On a big cardboard, draw certain regular figures with a pencil. Cut them with the help of a

pair of scissors. Measure the necessary lengths and calculate their areas.

4. VOLUME

You keep some books and notebooks in a metal box. Is it possible for you to keep more and more books and note books in the same box? It will be found that you can keep a particular number of books in the space available in the box.

Your mother asks you to buy one litre of gingelee oil from the shop. If you take a small vessel and go to the shop and ask the shop keeper to give you one litre of oil, what does the shop keeper say? He will say, "This vessel is too small to hold one litre oil. Bring a bigger vessel." What does he mean? That vessel does not contain the space to hold one litre oil.

You are riding on a bicycle. You feel that there is less air in the rear tube. You stop the cycle near a cycle shop and ask the keeper to pump in air for the rear tube. While pumping the air what will you or the shop keeper do? Often and often the tyre is pressed and checked by you whether the air. Why? If more air is pumped in, the tube will burst. Because the tube can hold air which is limited by the space available in the tube.

Thus we understand that solids, liquids and gases have volumes.

What is volume?

One of the properties of a body is to occupy space. The space occupied by a body is known as its volume.

For example, take a bottle of ink, a bucket of water and a cup of milk. Which has more volume? Immediately we say a bucket of water has more volume. We say so because the volume of bucket is greater than the volume of either the bottle or the cup.

Unit of Volume

Volume is a derived measurement because it is obtained from the fundamental measurement of length. That is, the unit of volume is obtained by calculating the cube of the unit of length.

Volume = length × length × length = $(\text{length})^3$

The unit of voume in *SI* is cubic metre. Another unit 'litre' is also used to measure the volume.

1 litre = 1000 *ml.* = 1000 *cc.* = 1/1000 cu.m.
= $1/10^3$ cu.m. = 1×10^{-3} cu.m.

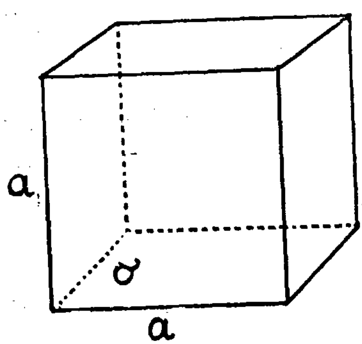


Fig. 17. Cube *a*—side

Measurement of Volume

The volumes of regular solids are calculated as follows:

(i) **Cube**

The volume of a cube with side '*a*' m.
= side × side × side
= '*a*' m. × '*a*' m. × '*a*' m.
= a^3 cu.m.

(ii) **Cuboid**

The volume of a cuboid with length '*l*' m., breadth '*b*' m. and height '*h*' m.

= length × breadth × height

= $l \times b \times h$ cu.m.

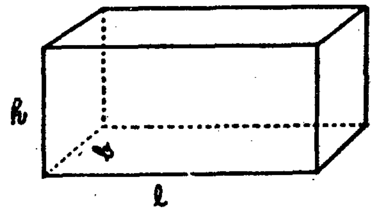


Fig. 18. Cuboid
***l*-length *b*-breadth *h*-height**

(iii) **Cylinder**

The volume of a cylinder with radius '*r*' m. and height '*h*' m.

= π × radius × radius × height.

= $\pi r^2 h$ cu.m.

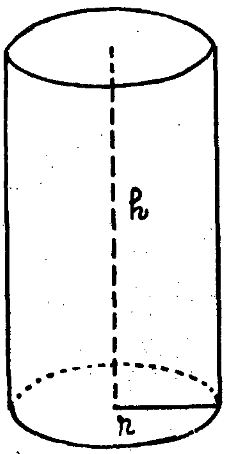


Fig. 19.
Cylinder
***h*-height *r*-radius**

(iv) **Sphere**

The volume of a sphere of radius '*r*' m. is

= 4/3 × π × radius × radius × radius

= $4/3 \times \pi \times r \times r \times r$

= $4/3\, \pi r^3$ cu.m.

Formulae are not used to measure the volumes of irregular solids and liquids. Why?



Fig. 20. Sphere

But by using a measuring jar, burette, pipette and overflow jar, we can find the volumes of the above objecst.

Measuring Jar

Take some liquid in a cylindrical jar to a particular height. If the area of cross section of the jar—the area of the bottom—the area of a circle—is multiplied by the height of water level from the bottom, we can get the volume of water.

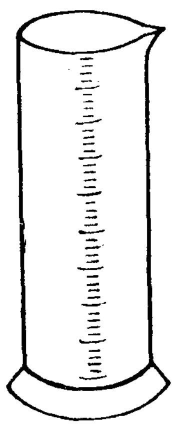


Fig. 21.
Measuring jar

If a cylindrical glass jar is taken and it is graduated in units of volume then it is known as measuring jar.

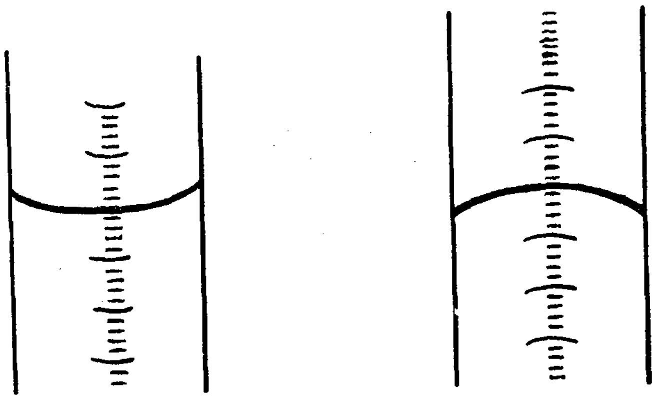
The measuring jar is a vessel of uniform cross section. It is made of glass. This is graduated in cubic centimetres starting from the bottom and going upwards. There are measuring jars with markings from zero cc. to 50 cc., 100 cc., 250 cc., and 500 cc.

Meniscus

When a liquid is taken in the measuring jar, what is the shape of the level? This must be noted.

The shape of the level of the liquid is known as meniscus. The meniscus of all the liquids except mercury are curved downwards and it is known as concave meniscus. The level of mercury is curved upwards and it is known as convex meniscus. While

measuring the levels of liquids, the readings which coincide with the meniscus must be taken.



(A) concave Meniscus   Fig. 22. Meniscus   (B) Convex Meniscus

Parallax Error

While measuring the volumes of liquids by using a measuring jar, our line of sight must be perpendi-

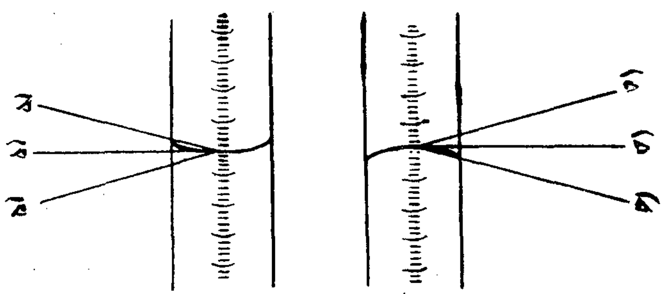


Fig. 23. Parallax Error

cular to the level of meniscus. The line of sight should not be slanted either upwards or downwards. If it is slanted then the error is called parallax error.

Rules to be considered before using Measuring Jar

1. The measuring jar should be dry and clean.
2. It should be washed by the same liquid which is to be measured.

(But we cannot wash the jar by liquids like mercury. Why not?)

Using the Measuring Jar

To find the volume of a solid

The measuring jar can be used to find the volumes of irregular solids. After cleaning it, a suitable quantity

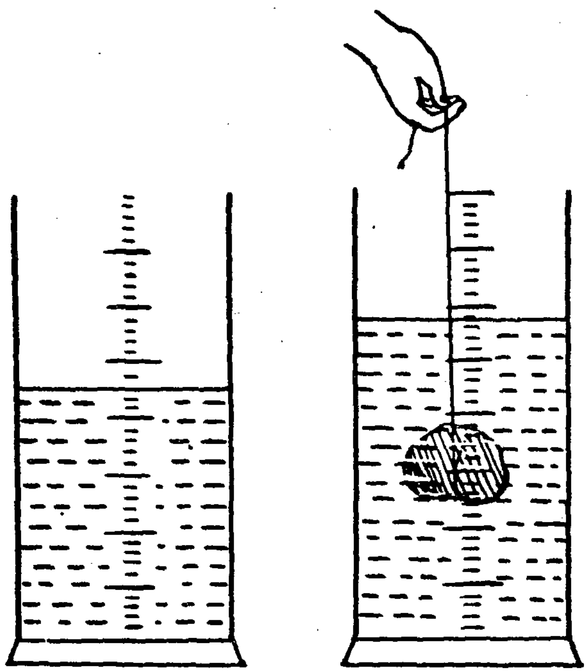


Fig. 24. To find the volume of a solid

of water is poured into it. The amount of water poured must be enough to immerse the solid, whose volume is to be found. The position of the meniscus of water level is noted. The given solid is tied to a thin thread and immersed in the water. The level of water rises. The raised level of water is noted. The difference between the two measurements of the levels of water gives the volume of the solid.

The level of water is changed and the above experiment is repeated several times. The readings are tabulated as follows. The average of the readings of the last column gives the volume of the given solid.

S. No.	First level of water	Level of water after immersing the solid	Volume of the solid
1.			
2.			
3.			
4.			
5.			
		Average volume of the solid	

Rules to be followed while using the Measuring Jar

1. The liquid should not be a solvent of the solid, whose volume is to be found.
2. While measuring the levels of liquid, the type of meniscus is noted and the readings must be exactly at the level of meniscus.
3. The readings are noted without parallax error.
4. If the graduations in the measuring jar cannot be seen clearly keep a white paper on the back side of the jar.

Overflow Jar

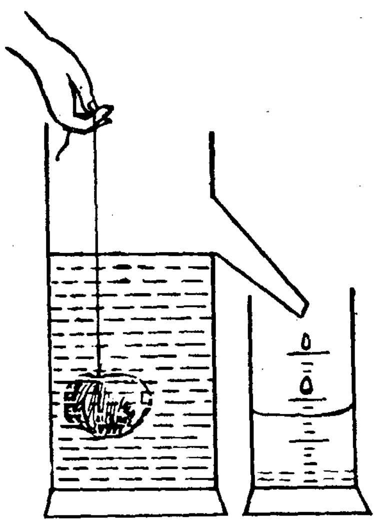


Fig. 25. Overflow jar

It is a cylindrical glass vessel. There is an overflow pipe at the centre which is known as spout. If more water is poured into it, the excess water overflows through the spout. After the dropping of water stops, a measuring jar is kept under the spout. A thread is tied to the solid, whose volume is to be found. It is slowly immersed into the overflow jar. An amount of water which is equal to the volume of solid overflows

into the measuring jar. By measuring the level of liquid in the measuring jar, the volume of the solid is found.

QUESTIONS

(A) Fill up the blanks in the following questions:

1. Volume is the derived measurement of ——.
2. The unit of volume in *SI* is ————.
3. One litre is equal to ————————.
4. The curved surface of mercury level is known as ————————.

(B) Match the following:

	Solids		**Volume**
1.	Cube	(a)	lbh cu.m.
2.	Cuboid	(b)	$4/3\ \pi r^3$ cu.m.
3.	Cylinder	(c)	a^3 cu.m.
4.	Sphere	(d)	$\pi r^2 h$ cu.m.
		(e)	$4\ \pi r^3$ cu.m.

(C) Answer the following questions in one or two words:

1. How many dimensions are needed to calculate the volume?
2. Name any two measuring vessels to determine the volume of irregular solids.
3. What is meant by meniscus?

4. Name the vessel which is used to measure the volume of an irregular solid, that is too big to be introduced into a measuing jar.

(D) **Answer the following questions in one or two sentences:**

1. Define: Volume.
2. Describe the two kinds of meniscus.
3. What is a measuring jar?
4. State the rules that are to be followed before using a measuring jar.
5. What is known as overflow jar?

(E) **Answer the following questions:**

1. State the rules that are to be carried out while using a measuring jar.
2. How do you find the volume of a solid using a measuring jar?
3. How do you find the volume of a solid using an overflow jar?

PROBLEMS

1. There is water up to 25 cc. in a measuring jar. If a solid is immersed in it, the level of water rises upto 32 cc. Calculate the volume of the body.
2. There is water in a measuring jar upto 128 cc. If a solid, of volume 16 cc, is

immersed in water, the water level will rise. Find the final level of water.

3. Convert the following volumes into cubic metres: (a) 7 litre (b) 1600 cc. (c) 12400 cu. mm.

4. The diameter of a wire is 1 *mm*. and its length is 28 *m*. Calculate its volume.

5. Find the volume of a cube with a side of 5 *m*.

6. Find the volume of a sphere as radius 21 *cm*.

EXERCISE

Try to construct an overflow jar with the help of an empty powder tin.

5. MOTION

Motion

Are all the living beings in the world in a state of rest? How do they fulfill their needs? All the living beings move from place to place and fulfill their needs.

The movement of the beings from place to place, i.e. displacement is known as motion. Hence the important property of motion is displacement.

The movement of a body when it is dropped, the upward movement of the flame are all examples of motion.

To move a cart—to move it from one place to another or to change its position—animals or machines are needed. To move a big stone, a crowbar and a man to handle it are necessary.

What is the state of a body when it does not move? It continues to be in the same position and it is said to be in a state of rest.

Can we say that any body in this world is in the same state of rest infinitely?

The earth spins about its axis and also revolves round the sun. What does it mean?

The earth is not in a state of rest but moves by spinning. The truth is that all the bodies in the earth also move along with the earth.

We say that a body at rest in the earth moves with respect to the earth. It is also correct that the above body is at rest with respect to other bodies in the earth.

Hence it is realised that all movements are related to one another.

For example, you are travelling with your friend in a bus. On the way, you see your teacher standing by the side of the road. He is now at rest, both of you are in motion. But you are at rest with respect to your friend. Thus it can be proved that all types of movements are related to each other.

Similarly consider a book on a table. The book as well as the table are at rest. Hence they are

in the state of rest related to one another. But with respect to the earth which is spinning they are in motion.

Two Types of Motion

When a body moves and if the motion of the body is in a straight line, then it is rectilinear motion. If the motion of the body is along curved line, then is known as curvilinear (circular) motion.

Displacement

Consider a particle which is displaced from *A* to *B*. The displacement of the particle from *A* to *B* can be in three different ways as in 1, 2 or 3.

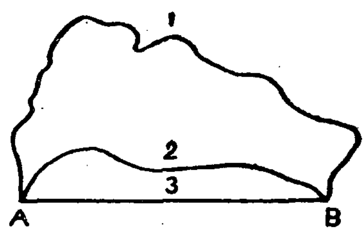


Fig. 26.
Displacement

In these types of displacements, what is the type of motion of the body along 1 or 2. What is typs of displacement along 3?

In these three types, the shortest displacement is the rectlinear motion, that is, along 3. But the distances travelled by the body along the other directions i.e, 1 and 2 are longer. To understand this, measure the three distances.

So, the displacement is the least distance travelled by the body in any direction.

Speed

A body takes time to change its position. For example, you take 30 minutes to go by walk from Your house to the school.

If you go on a bicycle you can cover the same distance within 10 minutes. The distance between the school and the house is not altered. But the rate of motion by walk and by bicycle is altered. This change is known as speed.

You travel the distance by a cycle at a greater speed than when you walk the distance. Instead, if a bus or car is used to cover the same distance the speed will increase and the time decreases.

So, to describe motion, the speed of the body is to be found.

For this, we must know the distance passed by a body and the time taken for travelling the distance.

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

For example, a car travels 450 kms. in 5 hours.

$$\therefore \text{ Speed} = \frac{450 \text{ km.}}{5 \text{ hrs.}} = 90 \text{ km./hr.}$$

Hence, the speed of the car is 90 km./ hr., that is, the car travels a distance of 90 km. in one hour. Therefore, the speed is denoted by the unit of km./hr. or m/s.

Speed and Velocity

Speed is the distance travelled by a body in a second. If we denote the speed of a body along a particular direction, then it is known as velocity.

Uniform Motion

If the speed of a body is uniform without any change then it is said to be in uniform motion. That means it travels with uniform speed or uniform velocity.

Time and Distance Graph

We can draw a graph with the time taken and the distance travelled by a body.

For example, a car moves with a particular speed and it travels certain distances at particular intervals of time. Then we can draw a graph with these data:

A car starts from a place at a distance of 97 km. at 4 hrs. 30 min. It reaches another point at a distance of 117 km. after ten minutes. That is, it travels 20 km. in 10 minutes. In the next 10 minutes, that is, after 20 minutes it reaches another point at a distance of 137 km., and in another 10 minutes, that is, after 30 minutes it reaches another point at a distance of 157 km. and so on. Hence for every 10 minutes it travels 20 kms. These are represented by the points *A*, *B* *C* & *D* respectively on the graph. If these points are joined together we obtain a straight line.

Time Hr.	Min.	Distance (km.)	Time Difference (Min.)	Distance travelled (km)
4	30	97	0	0
4	40	117	10	20
4	50	137	20	40
5	00	157	30	60
5	10	177	40	80

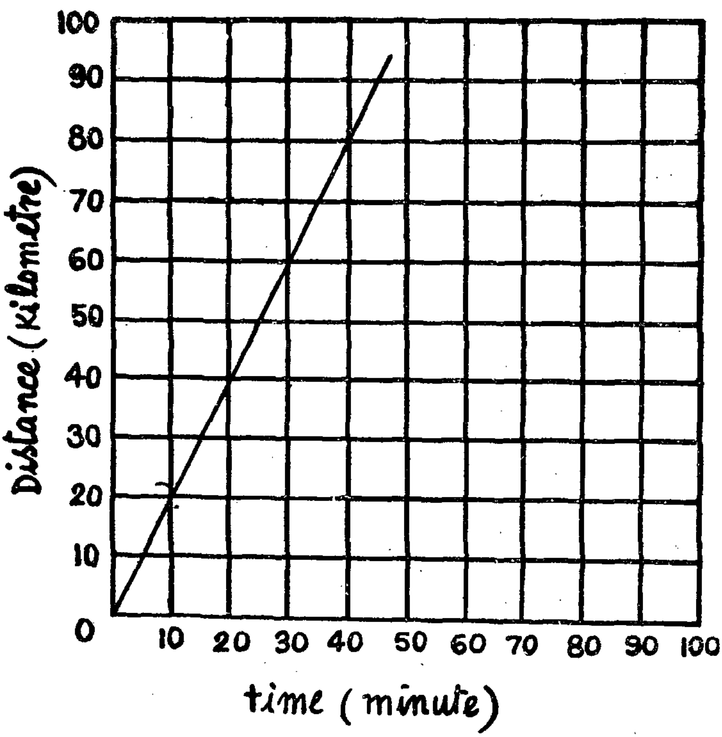


Fig. 27. Time - Distance Graph

So, if an object is moving with uniform speed, the graph obtained between the distance travelled and the time taken will be a straight line.

QUESTIONS

(A) Fill up the blanks in the following questions:

1. Dropped bodies fall ——————.
2. The important property of motion is ———
3. When we compare a body at rest with respect to the —————, then we can say it is in motion.
4. A body takes a particular ————— for displacement.
5. Speed = ——————.

(B) Answer the following questions in one or two words:

1. What is the movement of a body from one point to another called ?
2. What is the state of a body when it does not move ?
3. Mention the unit of speed.

(C) Answer the following questions in one or two sentences:

1. What is motion ?
2. What is rectilinear motion ?
3. What is circular motion ?
4. What is displacement ?

5. Define: Speed.
6. What is velocity?
7. State the difference between speed and velocity.
8. What is meant by uniform motion?

(D) **Answer the following questions:**

1. Prove with examples that all motions are related.
2. Describe the method of drawing a time-distance graph.

6. FORCE

Force

We have learnt that the motion is the displacement of a body from one place to another. What is the reason for this motion?

In our everyday life we see objects in motion. We also make things move. We see cars, bicycles, buses etc., moving along the road and aeroplanes fly in the sky. Ships sail in the seas.

When we come out of the house we pull the door shut. While entering a room we push open the door.

What is responsible for these types of motion?

Force is necessary for the movement of all bodies.

Is force needed only to move a body which is at rest? Force is also necessary to stop the motion of a body.

If a body experiences any change in its motion, it is due to some force acting on it.

Force is required to move a body from rest, to change its speed while it is in motion, to change its direction of motion and to arrest the motion of a body.

You pull a door shut with your hands while you close it and you exert a force on the door. At the same time, the door also exerts a force on your hands due to its weight.

Hence a force is brought into play on account of the physical contact between the door and your hands and in this manner bodies move.

If an object is at rest, it does not mean that there are no forces acting on it. An object will not move if there are equal and opposite forces acting on it.

Hence (i) Forces bring about motion (ii) A force does not act independently. When a force acts, there is also an opposite force.

There are forces which act between two bodies without any physical contact between them. The magnetic force and the gravitational force are examples for these types of forces.

Magnetic Force

Take a bar magnet near some iron nails. Observe what happens. Iron nails will be attracted by the magnet.

What is the reason for this attraction of nails by the bar magnet? Suppose you bring a piece of wood or a bar of copper or of brass near the nails. Are nails attracted? No.

From this we understand that only a magnet can attract nails. Hence the force of attraction exerted by a magnet is known as the magnetic force.

This force acts without any physical contact between the magnet and the nails.

The magnetic forces are found to be concentrated near the ends of a magnet. The two ends of the magnet are called the north pole and the south pole.

Bring the north pole of a bar magnet close to the south pole of another magnet. Observe what happens. You observe that one attracts the other. This force is called **the force of attraction.**

Similarly if two north poles are brought near each other one repels the other. This force is called the **force of repulsion**. A magnetic field exists around the magnet.

Gravitational Force

Drop a pencil from a height. See what happens. Why does the pencil fall?

One day the famous scientist **Sir Issac Newton** was in his garden. He noticed an apple falling from a tree. Immediately he began to think why the apple should come down and why should it not go up? He came to the conclusion that all the particles when dropped fall downwards like the apple. A stone which is thrown upwards also comes down after sometime.

How does a stone thrown upwards go up? To make it move up, we exert a force on the stone-by throwing it up. Why does the stone come down after sometime? Some other force must be pulling it downwards.

From the above facts, Newton found out that there is a force of attraction between any two objects. So the earth has a force of attraction which is known as the gravitational force.

Because of this force of attraction every body is attracted towards the centre of the earth.

Plumb Line

To find whether an object is vertical or not, a plumb-line is useful. A metal bob tied to a thread is called a plumb line. This is freely suspended from a point. Because of the gravitational force the plumb line is vertical. We can find out whether any object is vertical or not by using this principle.

The masons use a plumb line to know whether the wall is vertical or not while laying bricks.

In the physical balance also a plumb line is used to keep the balance in the horizontal position.

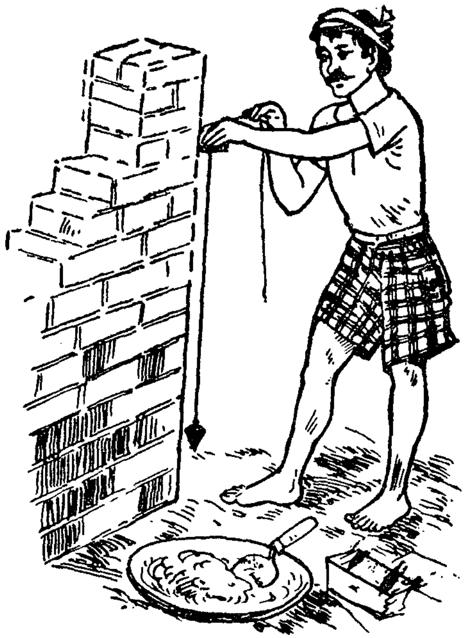


Fig. 28. Using a plumb line

Elastic Force

Take a rubber cord. Hold its one end by your hand and pull the other end. What happens? It is stretched. If you release it, it gets back to its original position.

You might have seen a catapult. By using this, birds are hit with stones. You can see that the rubber strip in it is stretched by pulling. When the stone is released, the rubber cord contracts.

Similarly when a spring is pulled, it expands in length and when released it contracts. What is the reason for this expansion and contraction? The elastic force is responsible for these.

A rubber strip is taken and its upper end is attached to a rigid support and is suspended from a stand as shown in Fig. 29. A metre scale is fixed vertically with the help of the metal stand. A scale pan is attached at the lower end of the rubber strip. There is a pointer near the lower end of the rubber strip and above the scale pan.

The initial reading of the pointer is noted with the help of the metre scale.

A 10 gm. weight is placed on the pan. What is the change found in the rubber strip? It expands because of the weight in the pan. The expansion is noted. 10 gm. weights. are added in steps and the corresponding readings are noted. The readings are tabulated as follows:

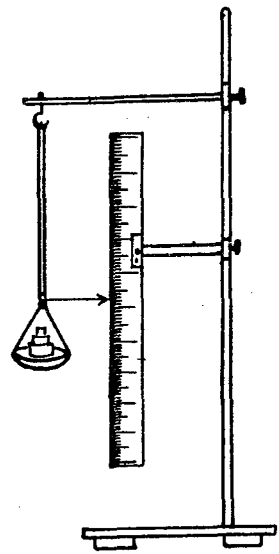


Fig. 29. Elastic force of a rubber strip

Weight	Readings of the pointer	Total Expansion of the Rubber strip	Expansion for a wt. of 10 gms.

The rubber strip is removed and the same experiment is repeated with a spring. The readings are tabulated in separate tabular columns.

What do you understand from these two experiments? The expansion of the rubber strip is uniform and the expansion is directly proportional to the load on the pan. We know that this is true for the spring also.

The gravitational force acts on the pan. To oppose this force there is an equal opposite force on the rubber strip. This is known as the elastic force.

Unit of Force

Newton (*N*)is the unit of force in *SI*. It is named after the scientist Sir Issac Newton who discovered the gravitational force.

Force does not only denote the magnitude but denotes the direction.

QUESTIONS

(A) **Fill up the blanks in the following:**

1. The reason for all motions is ______________________.

2. There is an ______________________ in an object when a force acts on it.

3. The magnetic force is found to be concentrated near the ______________________ of a magnet.

4. If the south pole of a magnet is brought near the north pole of another magnet, they ——————— each other.

5. If the north pole of a magnet is brought near the north pole of another magnet they ——————— each other.

6. Around a magnet a ——————— exists.

7. The scientist who discovered the gravitational force is ———————.

(B) **Answer in one or two words:**

1. Mention the nature of the forces in the following case and state whether they are the result of physical contact or not.

   (i) Kicking a foot ball

   (ii) Attraction of a nail by a bar magnet.

   (iii) Sucking the soft drink by means of a straw

   (iv) A fruit falling from a tree.

   (v) Motion of a wind mill.

2. How are the two ends of a magnet called ?

3. Why dose a body which is thrown upward return ?

4. Give examples of forces acting between two objects without any physical contact.

5. Name the device that is used to know whether a body is in vertical position or not.

6. Name the unit of force in *SI*.

(C) Answer the following in one or two sentences:

1. What is force?
2. Give examples of effects of the force on a body.
3. What is magnetic force?
4. What is gravitational force?
5. What is an elastic force?
6. Give examples of the uses of a plumb line.

(D) Answer the following question:

1. Describe an experiment to measure the elastic force and the expansion in length of a rubber strip or a spring.

7. FRICTIONAL FORCES

Frictional Force

We have learnt that force is responsible for motion. It is also responsible for stopping the motion of a body. How?

Kick a ball and the ball rolls on the ground. Dose it move continuously? What is the reason for the slowing down of the motion of the ball and its coming to rest? You don't stop it but it stops by itself. Why?

There is contact between the ground and the ball when it rolls on the ground. A force acts on the ball in a direction opposite to that of its motion.

This force retards the motion of the ball, and its speed decreases slowly and finally the ball comes to rest. The force which opposes the motion is known as frictional force.

So the force which opposes motion is called the frictional force.

Place a heavy brick on the ground. Can you move it with one finger? A frictional force acts between the ground and the brick. As the force exerted by your finger is less than the above frictional force, you cannot move the brick. But the same brick is moved by your hand. Why?

Similarly you cannot move a heavy almirah by yourself. Two or three people are needed. To push a heavy bus, many persons are needed.

Hence frictional force acts when an object slides or rolls over another object. If the surface of the body is rough—that is not smooth—the amount of frictional force increases. If the surface is smooth the force is less. The frictional force is greater if the weight of the object is more.

You can feel the difference between walking on an ordinary ground, and walking on a marble floor.

Do you know how to skate? Persons who skate, slide easily on the surface of ice. Guess the reason for this.

Advantages of the Frictional Force

The frictional force heps in our daily life in different ways. It is required for our walking without skidding and for the movement of vehicles. The frictional force is also useful in stopping the moving vehicles.

Disadvantages of Frictional Force

Frictional force reduces the uniform motion of machines. Hence fuel consumption increases. Moreover, many parts of the machines get worn out because of the frictional force.

Reduction of Frictional Force

How are the disadvantages of frictional forces reduced ?

More dust is deposited on a cycle if it is not cleaned for many days and you find it very hard to ride. If it is cleaned and suitable oil is applied to the various parts, then you feel the ride comfortable. Similarly grease or oil is applied to the parts of the machines and the frictional force is reduced. These types of oil and greases are called **Lubricants.**

Measurement of Frictional Force

A string is attached to a rectangular block of wood. The end of the string is attached to a spring balance. The wood is dragged on the table by holding the ring of the spring balance. The movement of wood is to be observed. If it does not move, more force is to be applied and now it moves.

To calculate the amount of force exerted, the initial reading of the pointer is noted before drag-

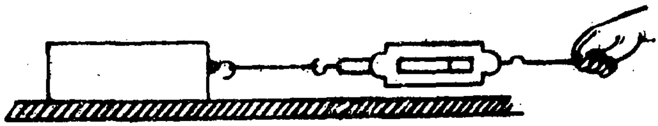


Fig. 30. Frictional force

ging the wood. While the block of wood is moving, the final reading is noted.

The experiment is repeated for several times and the readings of the pointer before the wood starts moving and when the wood just starts moving are noted in the following table:

S.No.	Reading of the spring before the wood starts moving	Reading of the spring when the wood just starts moving

Is there any difference between the two measurements? Which is more, the force required to make it move or to keep it moving?

Frictional Electric Force

Get a silk cloth, a glass rod and small pieces of paper.

A glass rod is rubbed well with silk and it is brought near the pieces of paper. Observewhat happens. The pieces of paper get attracted by the glass rod.

Another glass rod without being rubbed by silk is brought near the pieces of paper. Note whether they are attracted as before.

What is the reason for this?

The glass rod acquires a charge after being rubbed with the silk cloth and so it attracts the pieces of paper. This force which is responsible for attraction is known as electric force and this type of electricity is known as frictional electricity.

Instead of the glass rod, comb, pen, etc., can be rubbed with woollen cloth to get the electric force.

QUESTIONS

(A) Fill up the blanks in the following:

1. The force which opposes motion is called ——————.
2. If the surface of any object is not smooth, then the amount of frictional force—————— ——————.
3. To reduce friction—————————— are used.
4. If a glass rod is rubbed with silk and brought near pieces of paper, they are —————— ——————.

(B) **Answer the following questions in one or two words:**

1. Which is responsible for reducing the speed of moving particles?
2. Name the force that is used to stop the moving vehicles.
3. Give examples for lubricants.

(C) **Answer the following questions in one or two sentences:**

1. What is frictional force?
2. What are the advantages of frictional force?
3. What are the disadvantages of frictional force?
4. How do you reduce the amount of frictional force?
5. What is frictional electricity?

(D) **Answer the following question:**

1. Describe an experiment to measure the frictional force.

Exercise

Two cans tied to two strings are hung as shown in Fig. 31. Keep one can empty and the other filled with sand. The two cans are set in oscillation. Observe which moves quickly. Why? Arrest their oscillations at the same time. Which stops quickly? Why?

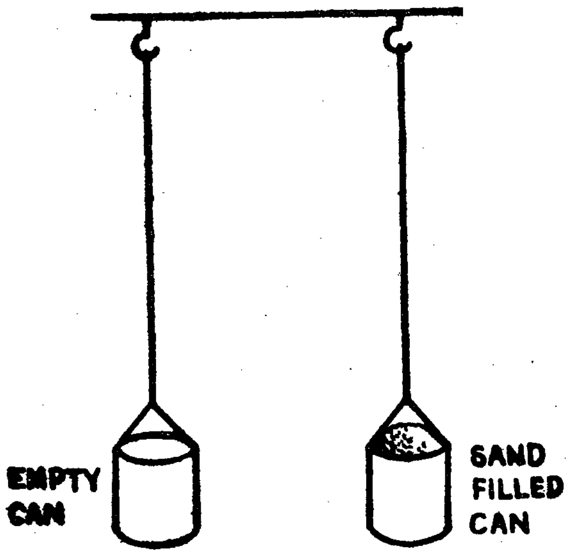


Fig. 31.

8. ENERGY

Energy

What do we say when a body is displaced? We say that it is in motion.

What is the reason for the motion of a body? It moves only when a force acts on it.

What do we mean when we say "bodies move because of force"? This means that they do work.

Energy is defined as the capacity to do work.

The food that you eat produces energy after undergoing certain chemical changes in the body. If

you have more energy you can run, lift, play and work more. Without energy no work can be done.

Consider the situation when you try to drag a box. You exert a force to push the box in one direction. By exerting that force you do work. To do that work you have to spend energy. But when the box is in motion, it gains energy.

Thus all the objects get energy. Stationary objects move when they gain energy. Objects in motion come to rest when they lose energy.

If a car or lorry is in motion, it means that it has energy. It gets energy by using the fuel 'petrol'. A train gets energy from coke or diesel or electricity and moves.

Kinds of Energy

Energy can be found in several forms like mechanical energy, electrical energy, light energy, chemical energy, heat energy, solar energy, atomic energy etc.,

Mechanical energy is of two kinds (i) Potential energy and (ii) Kinetic energy.

Potential Energy

Any object which is lifted from the ground gets energy. How?

Every body has weight. What is weight? Weight is the result of gravitational pull on the object.

When an object is lifted, it moves up against the gravitational force. By this we do work. and the work is not wasted. But it is stored.

Energy is stored in each object which is lifted above the surface of the earth. When that object falls to the surface of the earth we can regain that energy from that object. This kind of energy is known as potential energy.

So potential energy is stored energy, or energy possessed by a body by virtue of its position.

Compressed spring, stretched rubber strip, wound up spring of the watch, objects at height, compressed gas, the bullet in a rifle, the arrow in a bow, stored water are some examples of objects which possess potential energy.

Kinetic Energy

Kinetic energy is the energy possessed by a body by virtue of its motion.

A peg is lightly fixed on the ground by hammering it. Drop a big stone on the peg. Because of this the peg is driven into the ground. When the stone falls it gains kinetic energy and this drives the peg into the ground. If you drop the same stone with more speed (not as before) the peg is driven more into the ground. Like this, if a stone, heavier than the previous one, is dropped the peg is driven more into the ground.

So, kinetic energy increases when the velocity or mass increases.

A spring released from the compressed state, the released rubber strip after stretching, unwinding a clock

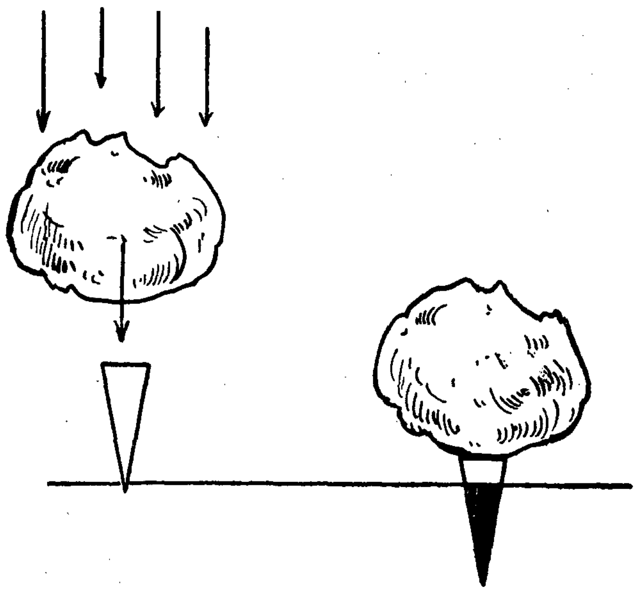


Fig. 32. Kinetic Erergy

spring, a moving rifle bullet, an arrow released from the bow, water forced out from a dam are some examples of objects which possess kinetic energy.

Electrical Energy

Electricity is also a from of energy. In our daily life we make use of electrical instruments not only in our houses but also in industries.

For example, equipments like the electric lamp, the electric fan, the electric furnace, the electric oven run on electricity. It is also used to operate water pumps.

Electricity is produced in three different ways.

Steam is obtained by burning coal and is used to drive a turbine. It turns a generator which produces electricity. This is known as thermal power.

Sometime the generators are operated by water stored in a dam and electricity is produced. This is known as hydro electric power.

The electricity produced with the help of atomic energy is known as atomic electricity.

We get magnetic energy, heat energy, light energy, sound energy from electrical energy.

Heat Energy

It is one form of natural energy. We get heat from natural as well as artificial sources.

From nature we get heat from the sun. By burning firewood, charcoal, coke, petrol, and kerosene etc., we get heat. We also get heat from electrical energy.

What are the uses of heat energy?

Water in the rivers, tanks and sea etc., evaporate due to the effect of sunlight and the clouds form in the sky and we get rain from them. The eggs of frogs, mosquitoes and fish in water are hatched by the heat of the sun.

To prepare food, to melt the metals, to kill harmful bacteria in water, to obtain steam from water in steam engines, heat energy is used.

Heat causes change of state in substances. What is change of state?

The conversion of a solid into a liquid, the liquid into vapour, and again the vapour into liquid, the liquid into solid is known as change of state.

Heat energy is also used for the expansion of solids, liquids and gases, to increase the temperature of substances and to cause chemical changes in certain substances.

Light Energy.

Light is also a kind of energy. Without light we cannot see objects around us.

We get light naturally from the sun. We are able to see objects with the help of that light. How? Sunlight falls on objects, gets reflected and reaches our eyes.

How do we get light at night? From the moon. Do we get the light direct from the moon? No. Sun's rays fall on the moon and the rays reflected from the moon are available as moonlight during the night. Similarly the other planets also give light. The stars also emit light like the sun.

Vegetable oils or kerosene is used to light the lamps. Thus we get artificial light. Nowadays by using the electrical energy, filament lamps and vapour lamps are used to give light.

Plants make use of sunlight to prepare starch. It is also helpful to maintain a fixed amount of oxygen in the atmosphere.

When sunlight falls on our body, we get vitamin *D*. If the clothes, bed and the food stuffs are exposed to sunlight, the germs are destroyed. Sunlignt is also used as an antiseptic. From these it can be seen that life for the living beings is impossible without sunlight.

Chemical Energy

Chemicals are of three different kinds and they are known as **elements**, **mixtures** and **compounds.** Oxygen, Nitrogen, and Iron are examples of elements. The air that we breathe is a good example for mixtures. Potassium Chlorate, Manganese dioxide are examples of compounds.

Most of the elements can be converted into compounds and most of the compounds can be split into elements. The energy required to effect such a change is called chemical energy.

For example iron and oxygen combine to give iron oxide. When potassium chlorate is heated, it is split into posassium chloride and oxygen·

The food eaten by the living beings undergo many changes in the body and hence they get the energy required for their movement. Chemical energy is converted into electrical energy in the electric cells like the Lechlanche and the Daniel cells. During electroplating electrical energy is converted to chemical energy.

Atomic Energy

All substances are made of atoms. Every atom contains a nucleus. Electrons revolve round

the nucleus which is at the centre of atom. It is similar to the planets which revolve round the sun. Like the energy that is stored up in the sun, there is also a good amount of energy stored up in the atomic nucleus. Energy can be released by splitting the atom. This energy is known as the atomic energy.

Atomic energy is used in industry, medicnie and agriculture.

Solar Energy

The sun is the basic natural source of energy. The energy available in the earth is directly or indirectly obtained from the sun.

The sun is solely responsible for light and heat energies. Researches are being carried out to find out the different uses which the heat energy obtained from the sun can be put to.

The solar furnace is constructed by using mirrors and lenses. Electricity is got from the sun and is used in artificial satellites like Aryabatta.

Conservation of Energy

If your mother gives you three rupees and asks you to buy 1 kilo of rice, You keep the money in your pocket and go to a shop with a bag. After buying the rice you give the money to the shop keeper. Now the money is not with you. Has it disappeared? No. The rice which is equal to the value of three rupees is in your bag. Energy is similar to this. The total amount of energy

ni the world does not change. But one form of energy is changed into another form of energy. Similarly we cannot create energy. It is possible to transform the energy from one kind to other. How?

For example, let us consider the production of thermal electricity. Coal is burnt, and the heat obtained converts water into steam. The steam rotates the turbine. By this the coil in the generator rotates between the two poles of a strong magnet. Thus electricity is produced. This electricity is useful to operate the machines, to light the lamps, to produce heat from certain equipments.

Coal

↓

Chemical Energy

↓

Heat Energy

↓

Kinetic Energy

↓

Electrical Energy

↓ ↓ ↓

Kinetic Energy | **Light Energy** | **Heat Energy**

Thus one form of energy is transformed into another from of energy. But it is not destroyed.

Transformation of Energy

1. Hammering a nail in the wall

Hammer is used to drive the nail into a wall. But to move the hammer you must have energy. You

get energy from the food that you eat which undergoes chemical changes in your body. By using that energy you drive the hammer which has potential energy. After hammering several times the nail is driven into the wall. If you touch the head of the nail you will feel that it is hot. This heat is produced because of the friction between the hammer and the nail.

So, the chemical energy is responsible for the transformation of the potential energy in the hammer into kinetic energy and produces heat energy.

2. **Falling of a stone from a height**

When a stone is at a height, it has potential energy. When it falls down, it gains kinetic energy because of its downward motion.

3. **Working of the Steam engine**

The chemical energy in the fuel 'coal' is transformed into heat energy when it burns. This heat converts water into steam. The steam drives the piston and kinetic energy, that is, mechanical energy is obtained.

4. The chemical energy in storage cells is converted into electrical energy.

5. In electric lamps, the electrical energy is converted into light energy and heat energy.

6. The electrical energy is converted into mechanical energy in electric motor.

7. In an atomic reactor, atomic energy is converted into heat energy and electrical energy.

Thus we understand the method of transformation of energy.

QUESTIONS

(A) Choose the best answer for the following:

1. Capacity for doing the work is (a) Energy (b) Heat (c) Chemical change (d) Height.
2. From which do the human beings get the energy to do work? (a) Machines (b) Hands (c) The food they eat.
3. Which produces the energy to operate the engines of car, rocket etc? (a) Magnets (b) Electricity (c) Heat (d) Air

(B) Select the fuels from the following list:

(a) Wood (b) brick (c) petrol (d) Alcohol (e) Sugar (f) Bread (g) Nails.

(C) Point out the type of energy produced in the following actions:

(a) A boy shoots an arrow from a bow.

(b) A big stone rolls down from the top of a mountain.

(c) Fire is produced by means of friction between two stones.

(d) Function of an electric oven.

(e) Oscillation of the pendulum of a clock.

(f) Boiling water.

(D) Give examples for the following:

(i) Conversion of potential energy into kinetic energy.

(ii) Conversion of electrical energy into mechanical energy.

(iii) Conversion of kinetic energy into electrical energy.

(iv) Conversion of heat energy into kinetic energy.

(v) Conversion of kinetic energy into potential energy.

(vi) Conversion of chemical energy into heat energy.

(E) Mention what type of transformation of energy takes place in the following examples:

(i) A cricket ball is thrown upwards and it reaches the ground again.

(ii) A swinging bob comes to rest.

(iii) Attraction of a nail by a magnet.

(iv) In an electric oven.

(v) In an electric bell.

(F) Answer the following questions in one or two words:

1. Mention the two forms of energy.

2. Name the three methods of producing electrical energe.
3. Give examples for 'fuels'.
4. Name the natural source of light and heat energies.

(G) **Answer the following questions in one or two sentences:**

1. What is energy?
2. Define potential energy.
3. Give any two examples of object which possess potential energy.
4. What is kinetic energy?
5. Give examples of objects which possess kinetic energy.
6. Mention the uses of electrical energy.
7. Mention the uses of heat energy.
8. What are the uses of sunlight?
9. What is solar energy?
10. Define conservation of energy.
11. Give any two examples for the transformation of energy.

For Thought

Write an essay about the transformation of energy that we get from the sun.

Exercise

Make a list of the machines that you find in your house and on the way when you go to school. Also write what kind of energy and transformation of energy is found in each one of them.

9. GRAVITATIONAL FORCE

In a circus, you would have noticed a man or a woman holding a long stick or umbrella and walking a long rope tied between two ends. While walking like that you would have also noticed how they lean their bodies either to the left or to the right? Can they walk on the rope without the long stick or the umbrella? How do they move their hands if they try to walk without them?

Try to jump from the place where you stand. Why does your body move downwards after going upwards for a while?

Why do bodies thrown upwards fall after sometime?

A scientist by name Newton thought about these things and found the answer. The answer to the above questions is the 'gravitational force'.

Gravitational Force

Earth has the property of attracting bodies. The earth attracts all objects towards its centre. This is known as gravitational force.

Centre of Gravity

The earth attracts an object towards its centre. If you break the object into two, the earth attracts

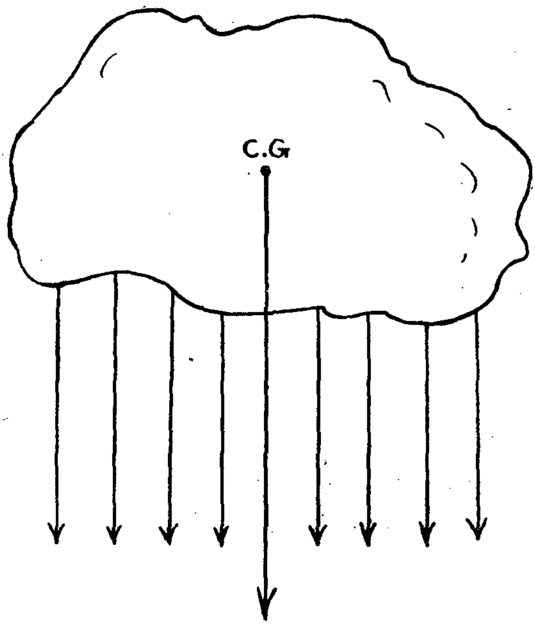


Fig. 33. C.G-Centre of Gravity

each piece. If you break those pieces into four, the earth attracts all the four pieces.

A body is made up of large number of particles. Each particle is attracted towards the centre of the earth. The gravitional force acting on all the particles are considered to be parallel forces. For all these forces there is a resultant force. This resultant force passes through a point on the body. This point is known as the centre of gravity. Hence each body has a centre of gravity.

The force attraction of a body towards the earth is known as its weight.

Hence the centre of gravity of a body may be defined as that point at which the weight of the body is concentrated for all positions of the body.

To find the Centre of Gravity of A Regular Lamina

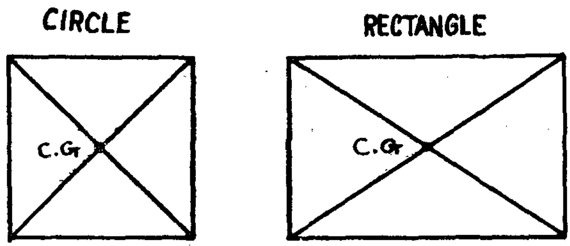


Fig. 34. Centre of Gravity (Square & Rectangle)

(i) The centre of gravity of a square or a rectangular lamina is the point of intersection of the two diagonals.

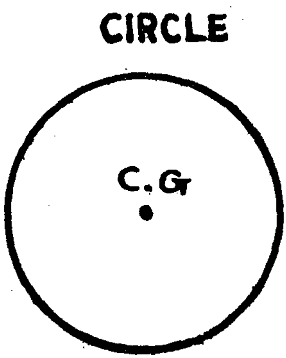


Fig. 35. Centre of Gravity (Circle)

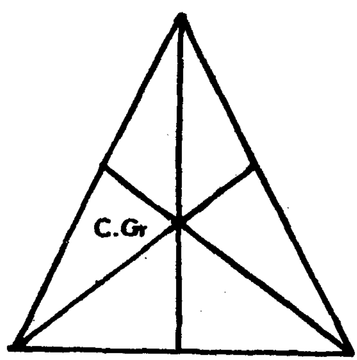


Fig. 36. Centre of Gravity (Triangle)

(ii) The centre of gravity of a circle is its centre.

(iii) The centre of gravity of a parallelogram is the point of intersection of the straight lines drawn from the centre of the opposite sides.

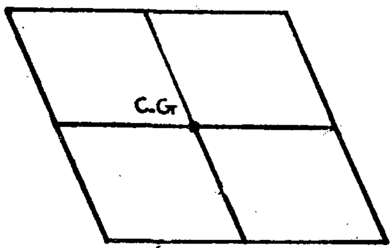


Fig. 37. Centre of Gravity (Parallaelogram)

(iv) The centre of gravity of a triangular plane figure is the point of intersection of the three medians from the three sides.

To find the Centre of Gravity of Regular Solids

(i) The centre of gravity of a cylinder is the mid-point of the central axis drawn between the centres of the top and bottom circular surfaces.

(ii) The centre of gravity of a sphere is its centre.

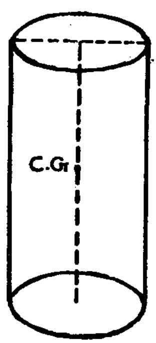


Fig. 38. Centre of Gravity (Cylinder)

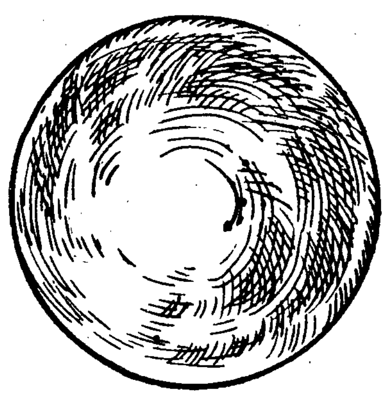


Fig. 39. Centre of Gravity (Sphere)

To Find the Centre of Gravity of an Irregular Lamina

A cardboard of irregular shape is taken. Three or four small holes are made at different corners of the board. The board is suspended with the help of a needle. It is fixed to a stand. From the same needle a plumb-line is suspended. The position of the plumb-line is drawn on the cardboard with a sharp pencil. The same card-board is suspended from the other holes and lines are drawn as described earlier. These straight lines cut at a particular point. This point of intersection of these straight lines is the centre of gravity of the lamina.

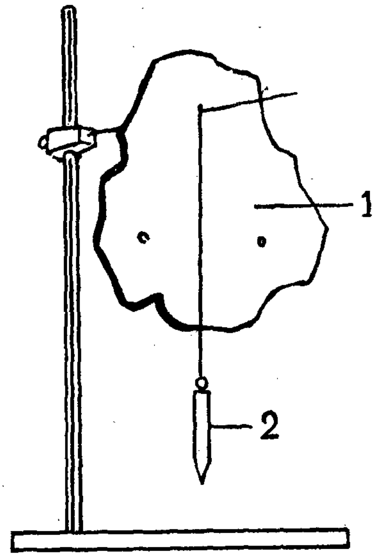


Fig. 40. To find the C.G. of a lamina of irregular shape

1. Irregular lamina
2. Plumb line

Equilibrium

Why does a body remain in a state of rest? (i) No force is acting on the body. (ii) The resultant of all the forces acting on the body must be zero.

And so the body is said to be in equilibrium.

Equilibrium is of three kinds. They are. (i) **Stable Equilibrium** (ii) **Unstable Equilibrium** (iii) **Neutral Equilibrium.**

We can understand the principle of the above three states of a body by using a funnel.

1. Stable Equilibrium

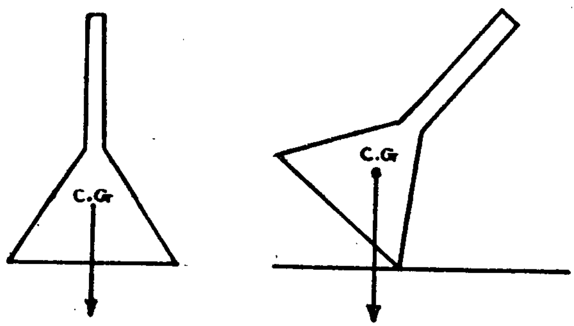


Fig. 41. Stable Equilibrium
C. G-Centre of Gravity

A funnel is taken and it is placed with its broad end on the table. Now the funnel is in a state of equilibrium. What will happen when it is tilted slightly? The tilted funnel gets back to its original state again. If it is tilted more it is changed permanently from this state. What is the reason for this?

The centre of gravity is at the centre of the broad portion. It is very near to the surface of the table. If the perpendicular line is drawn from the centre of gravity, it passes through its base. So the funnel does not change to a new state.

Hence, when we change the position of a body slightly and if it regains its original position, the body is said to be in stable equilibrium.

There are certain conditions for a body to be in stable equilibrium.

What are they?

(i) The base of the body must be broad.

(ii) The centre of gravity must be very close to the base.

(iii) The perpendicular line drawn from the centre of gravity to the earth must lie within its base.

2. Unstable Equilibrium

The funnel is placed vertically with its narrow end down on the table. It falls down when it is

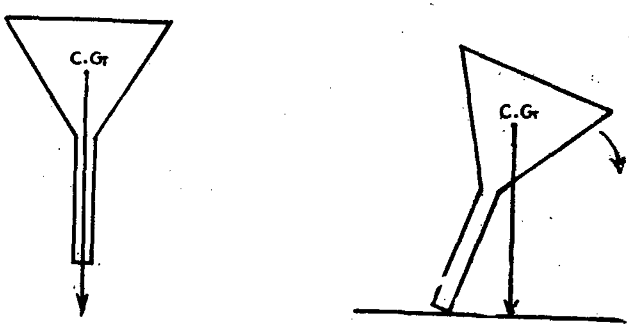


Fig. 42. Unstable Equilibrium
C. G - Centre of Gravity

tilted slightly. That is, it changes from this state to a new one. Why?

(i) The base is narrower than the upper surface.

(ii) The centre of gravity is at a greater height from the base.

(iii) When it is tilted, the perpendicular line drawn from the centre of gravity to the earth does not fall within the base.

When a body is tilted a little and if the object does not regain its old position, then we say that it is in a state of unstable equilibrium.

3. Neutral Equilibrium

Lastly, the funnel is placed on its side. If it is pushed, it merely rolls on the table. It

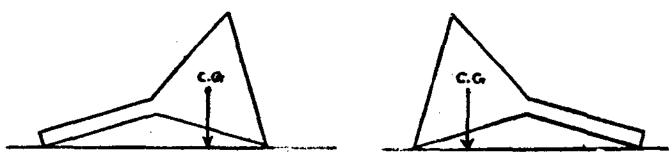


Fig. 43. Neutral Equilibrium
C. G - Centre of Gravity

tilts slightly and in a new position it is in the same state of rest as before. That means it does not net a new state and also it is not in its old position.

Now (i) the base is broader than before.

(ii) The centre of gravity is very near the base.

So there is no change however much it is moved. This is called neutral equilibrium.

When a body is tilted, the position of the centre of gravity is neither raised nor lowered, and in this position it is said to be in neutral equilibrium.

QUESTIONS

(A) Fill up the blanks in the following:

1. The force of attraction of all bodies by the earth towards its centre is known as ——————————.

2.

S.No.	Body	Centre of Gravity
1.	Cylinder	————————
2.	———— (or) ————	Its centre
3.	———— (or) ————	Point of intersection of diagonals
4.	Parellelogram	————————
5.	Triangle	————————

(B) Answer the following in one or two words:

1. Name the device that is used to find the centre of gravity of an irregular lamina.

2. Mention the three kinds of equilibrium.

(C) Answer the following in one or two sentences:

1. Define centre of gravity.
2. Why does a body continue to remain in its state of rest?
3. What is equilibrium?
4. What is meant by stable equilibrium?
5. State the conditions of a body to remain in stable equilibrium.
6. What is unstable equilibrium?
7. What is neutral equilibrium?

(D) Answer the following:

1. How do you determine the centre of gravity of an irregular lamina?

(E) Describe the experiment for determining the position of an irregular lamina.

For Thought

State the reasons for the following:

1. A man leans his body when he carries some articles on his back. Why?
2. In which direction will a man lean his body when he carries a bucket of water in his right hand? Why?
3. Tumblers are easily tilted than the cups. Why?
4. A tower becomes narrower as its height increases.

5. Heavy goods are stored in the hold of a ship. Why?
6. Why do we swing our hands when we walk fast?
7. We lean forward as we climb up a flight of stairs. Why?
8. You cannot get up from a chair without leaning your body. Why?
9. A chair is more stable than a tripot. Account for it.
10. The leaning tower of Pisa has not fallen down. Why?
11. An open umbrella is kept on the floor. In what state of equilibrium does it remain?
12. A bus does not overturn even if it is moving at high speed. Why?
13. The gravitational force does not affect the movement of a rolling ball. Why?

Exercise

Cut the figure of your country from an atlas. Paste it on a thick card board. Cut the figure correctly according to the outline. Find its centre of gravity. Find the name of the town or city or village where the centre of gravity lies.

10. SIMPLE MACHINES

Machine

What is energy? The capacity to do work is energy.

To get energy from nature, man made use air and of water. But natural forces prevented the use of such energies. So man had to construct some machines to bring the natural forces under his control.

What is a machine?

Machine does not give energy. But it is a device to do the work which gives energy quickly and easily.

For example, what will you do to get one bucket of water from a well? You may tie a rope to the bucket and lower it into the well. When you pull it upwards you will find it very difficult.

Suppose you use a pulley and tie it at the top and the rope is sent through the pulley. Now you will feel, that it is easier to pull the bucket of water upwards.

Similarly try to overturn a very big stone with your hands. Are you able to do it? No. Try to do the same with an iron crow bar. The big stone is easily overturned.

Thus, to simplify the work and to reduce physical exertion, certain devices are used and they are known as machines.

A simple machine is a device by which a force applied at one point is made available at some other point.

Uses of Machines

The simple machines are used in order to (i) transform one kind of energy into another; (ii)

transfer energy from one place to another (iii) increase the force (iv) increase the speed. (v) change the direction of a force. Thus machines are used for many purposes.

Kinds of Machines

Machines are of different kinds. Lever, inclined plane, pulleys, wheel and axle, wedge, screw etc., are the various types of machines.

Parts of Machines

All the machines rotate about a point and this point is known as **fulcrum.** We use a machine in order to mov or lift a body and this body is known as **load** or **weight.** The force that is applied to lift or move a body is called **effort.**

Lever

Lever is a kind of simple machine.

The lever is a rigid bar capable of revolving about a point of support. The point at which it is supported so as to revolve is called the fulcrum. The point where the effort is applied is called the point of application of the effort. The point through which the weight is moved is called the point of application of the load (weight).

The distance between the fulcrum and the point of application of the effort is called the **effort arm.** The distance between the fulcrum and the point of application of the resistance is called the **load arm.**

Principle of Lever

The relation, Load × Load Arm = Effort × Effort Arm is known as the principle of a lever.

Mechanical Advantage

The amount of manual work is reduced in using machines. We call this **mechanical advantage.**

The ratio between the load and the effort is known as Mechanical Advantage.

$$\text{Mechanical Advantage} = \frac{\text{Load}}{\text{Effort}}$$

According to the principle of the lever,

$$\text{Load} \times \text{Load arm} = \text{Effort} \times \text{Effort arm}$$

$$\text{i.e,} \quad \frac{\text{Load}}{\text{Effort}} = \frac{\text{Effort Arm}}{\text{Load Arm}}$$

$$\therefore \text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{Effort Arm}}{\text{Load Arm}}$$

Classification of Levers

The lever is classified into three kinds. They are: (i) First order of Levers (ii) Second Order of Levers and (iii) Third order of levers.

The First order of Levers

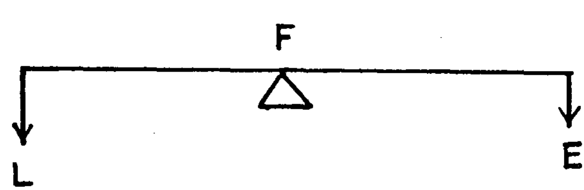
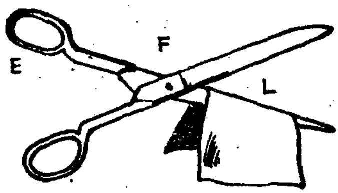
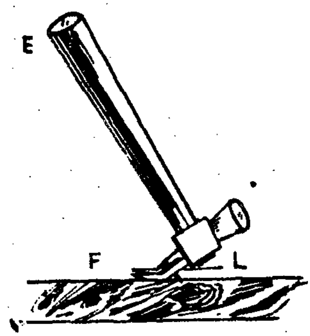


Fig. 44. First order of Lever
F - Fulcrum L - Load E - Effort

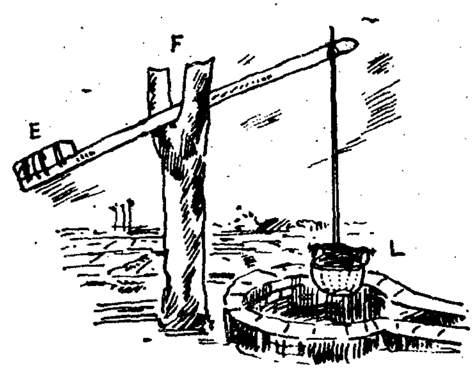
The fulcrum lies between the point of application of the effort and the point of application of the load in the first order of levers.



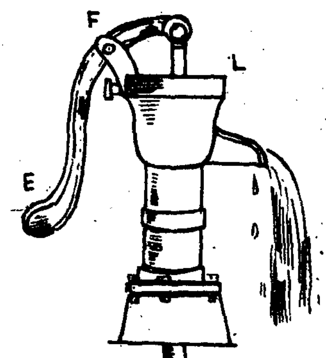
(a)
Scissors



(b)
Nail extractor



(c)
Arrangement for lifting water from well.



(d)
Handle of a water lifting pump

Fig. 45.

A pair of scissors, nail extractor, see-saw arrangement for lifting water from wells, the handle of

a water lifting pump etc. are examples of the first order of levers.

In the first order of lever the M.A. is equal to 1 or less than 1 or greater than 1.

If the lengths of load arm and effort arm are equal, M.A. is equal to 1. If the effort arm is longer than the load arm, M.A. is greater than 1. If the load arm is longer than the effort arm, M.A. is less than 1.

Second order of Levers

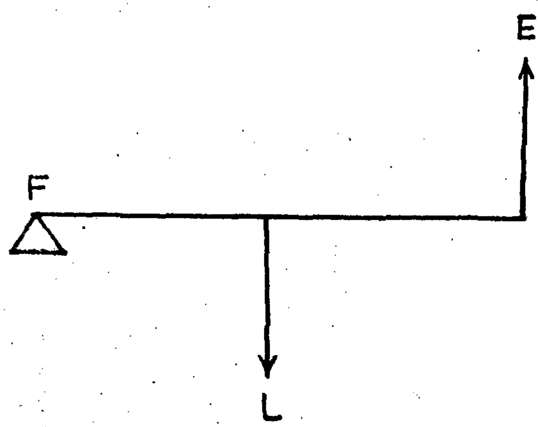
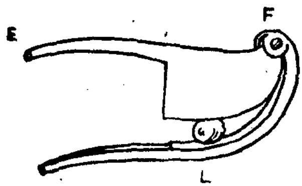


Fig. 46. Second order of levers
F-Fulcrum L-Load E-Effort

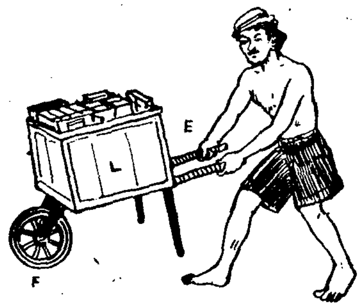
In the second order of levers, the point of application of the load is between the point of application of the effort and the fulcrum.

Nut slicer, wheel barrow, door, oar, the crowbar used for lifting stones are examples of the second order of levers.

In this type of lever, the effort arm is always longer than the load arm. So the M.A. is always greater than 1.

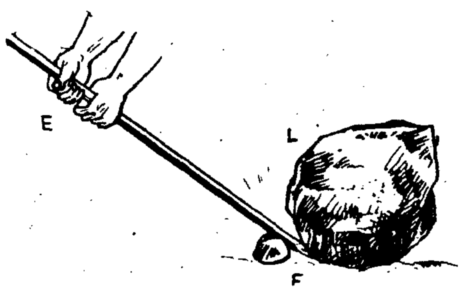


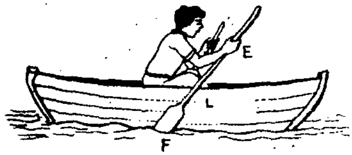
(a)
Nut slicer



(b)
Wheel barrow

(c)
Crow-bar used for lifting stone





(d)
Oar of a boat

Fig. 47.

Third order of Levers

The point of application of the effort lies between the point of application of the load and the fulcrum.

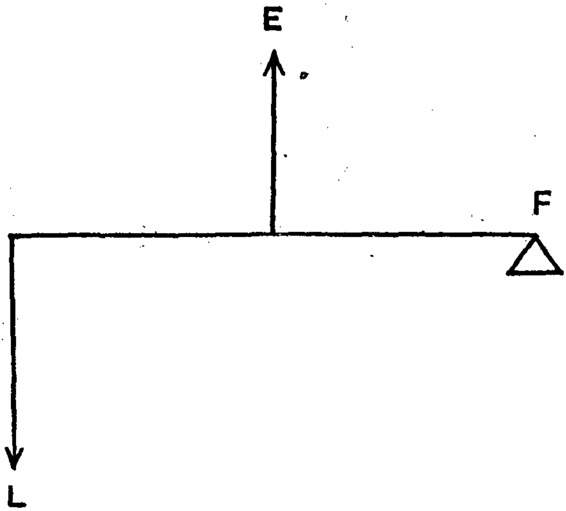
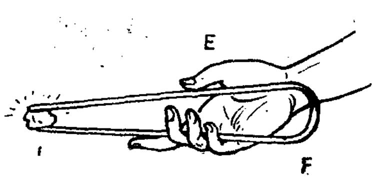


Fig. 48. Third order of levers
F-Fulcrum L-Load E-Effort

Forceps, fire tongs, fore arm are examples for the third order of levers.



(a)
Fire tongs

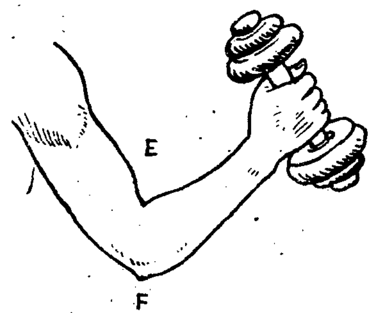


Fig. 49.

(b)
Fore arm

In this type of lever, the effort arm is always shorter than the load arm. So the M.A. is always less than 1.

Pulleys

We use pulleys for drawing water from the well. Suppose there is no pulley to draw water from the well, then we have to spend more energy. Why?

The gravitational force pulls the bucket of water downwards. We have to apply the force to pull it upwards against the gravitational force. Hence we have to spend more energy.

But when we make use of a pulley we apply the force in the downward direction. The directions of the gravitational force and the force applied to lift the bucket are the same. So we do not spend more energy.

What is a pulley?

A pulley is a wheel that rotates readily on an axle which in turn is mounted on a frame. It has a groove at the centre all along its circumference.

Kinds of Pulleys

Pulleys are of two kinds. They are the fixed pulleys and the movable pulleys.

If the pulley does not move up and down and instead it remains in a fixed position, it is called a fixed pulley. The pulley which moves from its position is known as movable pulley.

Pulleys are examples of the first order of levers.

Fixed Pulley

A fixed pulley is attached to a frame. A string is sent through its groove. A body weighing 200g. is attached to one end of the string and to the other end a scale pan is attached. When 200 g. weight pulls downwards the empty scale pan goes upwards.

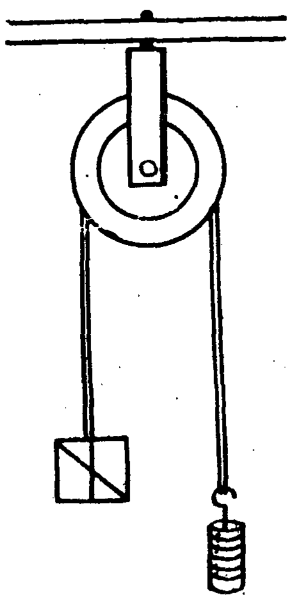


Fig. 50. Fixed Pulley

Weights are added little by little in the pan till the weights on both sides are in equilibrium. Small weights are added till the 200g weight just moves up. The total amount of weights in the scale pan are noted. Now some weights are removed one by one from the pan till the 200 g. weight comes down. The weights in the pan are noted. The average of the weights is found. The weight of scale pan is also added to this weight. This gives the effort for overcoming the 200 gram weight.

Different weights are used as loads and the corresponding efforts required to overcome them are noted by repeating the experiment.

The readings are tabulated as follows:

S. No.	Weight	Weight Required to make the load go up	Weight Required to make the load go down	Effort	
				Average	Average Weight + Weight of Scale pan

In the last column, it is found that the effort used to overcome the weight is equal to the weight.

QUESTIONS

(A) **Fill up the blanks in the following:**

1. The capacity to do work is ————.
2. The device which is used to simplify work is known as ——————.
3. The point of support about which the simple machine moves is known as ————————————.
4. To move or lift a body which is known as ——————————, machine is used.

5. The force applied to displace or lift a body in a machine is called ——————.

6. The distance between the point of application of the effort and fulcrum is known as —————————.

7. The distance between the point of application of load and fulcrum is known as —————————.

8. The fulcrum lies between the points of application of effort and load in ———— of lever.

9. If the point of application of the load is between the point of application of the effort and the fulcrum, it is known as the ———————— of lever.

10. In the ———————— of lever, the point of application of the effort lies between the point of application of the load and the fulcrum.

(B) **Answer the following questions in one or two words:**

1. What are the two different kinds of simple machines?
2. State the principle of lever.
3. Mention the three kinds of lever.
4. What is the mechanical advantage of I the order of levers?
5. What is the machanical advantage of the II order of levers?

6. What is the mechanical advantage of the III order of levers?
7. Mention the two kinds of pulleys.
8. What type of machine is a pulley?
9. What is the ratio of the load and the effort in the fixed pulley?

(C) Answer the following in one or two sentences:

1. Define a simple machine.
2. What are the uses of simple machines?
3. What is a lever?
4. Define: Mechanical Advantage.
5. What is a pulley?

(D) Answer the following:

1. Describe the three types of levers with suitable diagrams and give some examples for each type.
2. How do you prove that the load and effort are equal in a fixed pulley?

II. FLUIDS

11. LIQUIDS

Matter

How do we feel the presence of the objects around us?

By sense of sight, sense of smell, sense of touch, sense of taste and sense of sound.

What do we call the objects whose presence is felt by different types of senses? They are called matter.

What is matter?

The objects which occupy space, capable of being subjected to pressure, has porosity, has the ability to resist force, has inertia and weight are known as matter.

All matter in this world are generally divided into three kinds. They are solids, liquids and gases. Each has certain characteristic properties.

Fluids

Of the three kinds of matter, the solid has definite shape. It has the property of rigidity. It has more inertia.

But liquids and gases have no definite shape. They always take the shape of the vessel in which

they are kept. They have low inertia. If they are kept at a place they tend to flow freely around the places of their existence. So, liquids and gases are called fluids.

Properties of Liquids

Let us take some amount of liquid in a vessel. It presses downwards at the bottom of the vessel. It also presses the vessel sidewards and upwards. If a hole is made at the side of the vessel, the liquid flows through it at a high pressure.

Hence liquids exert pressure on all sides of the vessel in which it is kept.

We have already seen that liquids have no definite shape. They always get the shape of the vessel in which they are kept.

Let us find out the type of surface of the liquids like water, kerosene etc., kept in the vessel. The surfaces of all liquids like water in the tank, lake etc., are perfectly horizontal.

These are the general properties of all liquids.

Expt.

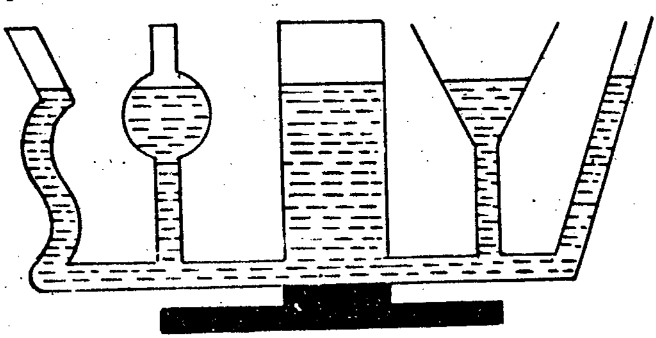


Fig. 51. Liquids always find their own level

The instrument shown in Fig. 51 is a device to explain the property that liquids always find their own level.

It contains five limbs with different shapes and volumes and are interconnected by a horizontal tube at the bottom. The water is poured through any one of the tubes and the level of water in the other tubes are noted side by side. It can be seen that the level of water in all the tubes is the same. Even if the apparatus is filled with some other liquid other than water, the level is the same in all the limbs.

What do we learn from this?

All liquids find their own level. The height of liquid level in the tube is independent of the shape or volume of the tube.

What is the use of this property of liquid?

Because of this, liquids flow from a higher level to a lower level. The instruments, water level and the spirit level are constructed on the basis of the above property.

Water Level

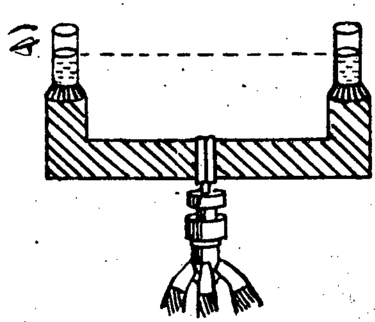


Fig. 52. Water level

A water level is shown in Fig. 52.

Two glass tubes of equal lengths are fitted vertically at the two ends of a metal tube (shaped '⊔') bent at right angles on either side. This is set on a tripod stand horizontally.

Water, tinted with red dye is poured into the tube upto a sufficient level. The levels of the red coloured water can be seen in the glass tubes.

The metal tube is fixed on a base which is capable of free rotation. Therefore it is possible to turn the metal tube in any required direction.

How to make use of the Water Level?

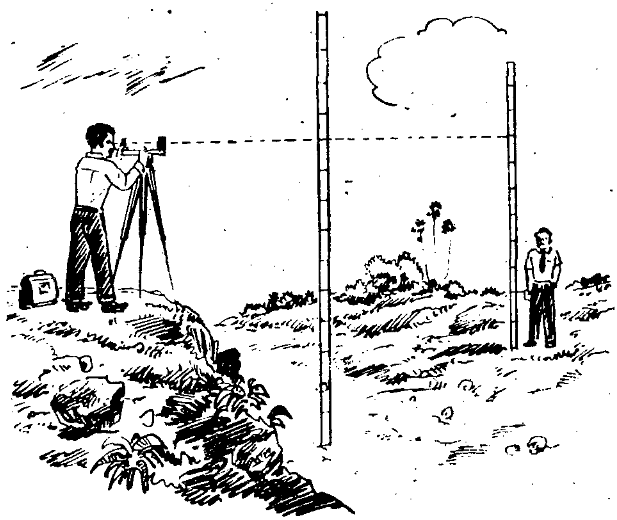


Fig. 53. Making use of the water level

Water level is used to locate and measure elevations and depressions on a surface.

For this purpose, water level is installed vertically on a surface. The levels of water in both the tubes are horizontal. A little farther away from the instrument, a vertical post, which is graduated in metres and centimetres, is kept in the vertical position.

The water level is viewed and the corresponding height on the vertical post is also read out and noted. Then the scale post is removed and moved on to another position and the reading is taken again as before. The difference between these two levels gives the difference in the height i.e. elevation or depression of the two positions. A telescope is fixed in the direction parallel to the water level in the two limbs. Therefore it is possible to read the graduations quite conveniently.

Uses of Water Level

Land Surveyors use this instrument to record the elevation and depression of the land. This instrument is mostly used to construct the roads on mountains, highways and for laying canals.

Spirit Level

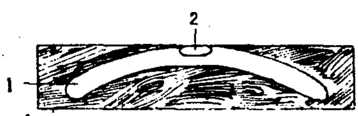


Fig. 54. Spirit Level

1. Spirit in a glass tube
2. Air bubble

The spirit level consists of a slightly curved glass tube which is filled almost completely with spirit. There is an air bubble inside. The ends of the tubes are sealed. This tube is embedded in a metal or wooden box. The bubble is visible and is covered by a glass plate.

When the box is kept on a plane horizontal surface, the air bubble will occupy exactly the central position which is marked on the glass. If the surface is not horizontal, the bubble will move towards the place or point at a higher level.

How to make use of the Spirit Level?

The spirit level is kept on a surface in a particular direction. If the air bubble occupies the central position, the instrument is removed and kept in a direction perpendicular to the initial direction. If the air bubble again occupies the central position, then the surface is horizontal. If the air bubble does not occupy the central position, then the surface at the higher level should be lowered or the surface at the lower level should be raised and vice versa to make the surface perfectly horizontal.

Uses

The spirit level is used to find whether a surface is horizontal or inclined. It is generally used by masons and carpenters. It is also used in the laboratories to set certain instruments like the physical balance etc., horizontal.

Artesian Wells

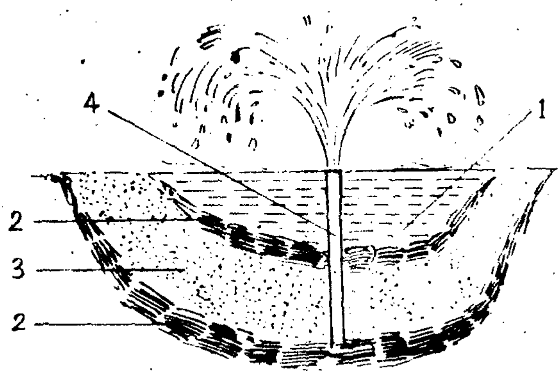


Fig. 55. Artesian well

1. Water reservoir 2. Rocky stratum
3. Sandy stratum 4. Pipe

When the earth is dug out in low level pits or when iron tubes are driven into the earth, water will come out with great force through the opening. The principle that 'liquids always find their own level' is applied in this case.

In the earth, shaped like a basin there are alternate layers of sand and hard rock. The water that stagnates there and the rain water that falls in the surrounding area, seep through the sand and are trapped in the layers of rocks. When an iron pipe is driven through it, the trapped water rushes out like a fountain through the pipe. This water flows out because it tries to find its own level.

Such wells are called Artesian wells. Why?

These kind of wells were first found in the province Artios in France. So these wells are called Artesian wells.

Siphon

The device which is used to transfer water from a big vessel which is at a higher level without directly pouring it into another vessel at a lower level is known as Siphon.

Construction

Siphon is a tube made of glass or rubber or plastic.

A glass siphon is a long tube which contains two limbs bent twice at right angles. One of its limbs is short and the other is long.

Experiment:

A beaker filled with water is kept at a higher level. Another empty beaker is placed at a lower level. The short limb of the siphon tube is kept immersed in water at the higher level. The other end of the long limb is kept in the empty beaker at a lower level. The air is sucked by keeping the mouth at the end of the long limb. (or the siphon is filled with water and the two ends are closed with fingers and the short limb is immersed in water at the higher level and the fingers are removed.) Now it is seen that the water flows from the higher level into the empty beaker at the lower level through the siphon tube.

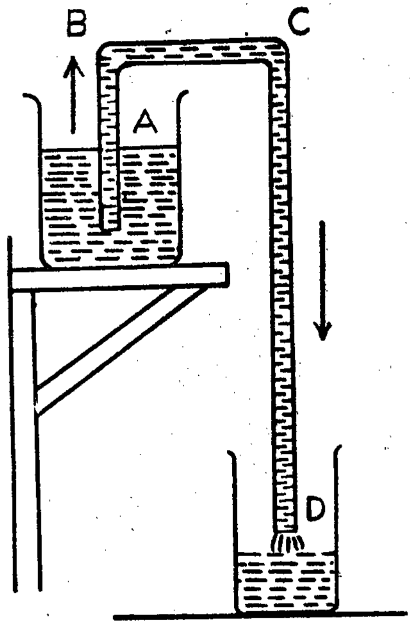


Fig. 56. Siphon

The Working of the Siphon

In the Fig. 56 *ABCD* is the siphon and is filled with water. Let the height of the tube from the water level in the beaker to *B* be 50 cm. Similarly let the height of the tube from the end of the long tube to *C* be 100 cm. If the atmospheric pressure is 1026 cm., then

Pressure at B = 1026 — 50 = 976 cm.

Pressure at C = 1026 — 100 = 926 cm.

Since the pressure at B is greater than the pressure at C, the water at the point of higher pressure B flows towards the lower pressure point C.

The liquid flows through the siphon till (i) the levels become equal. (ii) till the pressures at B & C become equal. (iii) till all the liquid at the higher level flows out.

Siphon does not function in vacuum as it requires air pressure for its working.

Safety Siphon

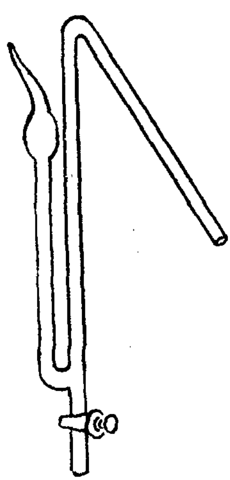


Fig. 57.
Safety Siphon

The safety siphon is used for transferring the acids and poisonous liquids.

It has a short and a long limb like the siphon. A third limb with a bulb is connected to the longer limb. There is also a stop cock at the bottom of the longer limb.

The short limb is kept in the acid or the poisonous liquid. The air is sucked through the third limb. The liquid level rises upto the broad bulb. When the

stop cock is opened the liquid flows through the longer limb.

The safety siphon helps a great deal in preventing the liquid from entering the mouth while sucking.

Conditions for the Working of the Siphon

1. One of the limbs of the siphon should be short and the other long.
2. The short limb of the siphon should be in the liquid, kept at a higher level and the long limb should be kept in the vessel at a lower level.
3. The siphon tube should be filled with the liquid to be transferred.
4. Atmospheric pressure is required for the working of the siphon. It does not work in vacuum.

Uses of the Siphon

1. Without tilting the vessel, the liquid kept in a big vessel can be transferred to another vessel kept at a lower level.
2. Liquids like petrol etc., kept in heavy drums, which cannot be tilted, can be transferred to small containers with the help of a siphon.
3. If the liquid contains suspended impurities like dirt and sediments, it is kept undisturbed for sometime. When they settle down at the bottom of the vessel, the clear liquid

at the top can be removed with the help of the siphon.

4. Two immiscible liquids like kerosene and water stand separately in a vessel. The liquid which floats on another liquid can be separated with the help of the siphon.
5. It is also used in the flush out tanks for automatic flushing.
6. There is a siphon arrangement in the flush-out latrines.

There is always some amount of water in the water trap. This prevents the bad odour from spreading into the house. Too much of water in it is drained out immediately leaving only a small amount of it just to cover the opening.

Tantalus Cup

This is a device which is based on the principle of the siphon. Inside a glass vessel, which is like a small measuring jar, there is a bent tube which acts as a siphon as shown in Fig. 58. One end of the tube opens in the innermost side of the glass vessel and the other end is at the bottom.

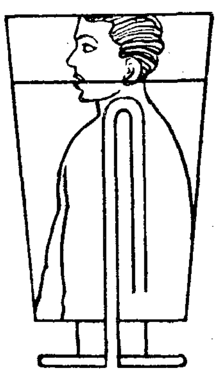


Fig. 58.
Tantalus cup

Water is poured into it, until the bent tube is immersed. If more water is poured into it, it is drained off through the open end of the bent tube. This bent tube acts as the siphon.

Suppose a doll is inserted in this cup just above the bent tube we can say that water which is poured in the cup is drunk by the doll.

QUESTIONS

(A) Fill up the blanks in the following:

1. The objects whose presence is felt by different types of senses, are called ——————————————.
2. The matter which has definite shape, rigidity, and inertia is known as ————————.
3. The liquids and gases are called ——————————————.
4. The upper surfaces of all the liquids are ————————————.
5. Land surveyors use the instrument ———————————— to record the elevation and depression of the land.
6. The liquid used in the spirit level is ————————————.
7. Artesian wells were first found in the province of ——————— in France.

(B) Answer the following in one or two words:

1. State the three states in which matter exists.
2. Name the states of matter that have no regular shape.

3. Name the devices that are constructed on the basis of the principle that liquids find their own level.
4. What is the name of the device that is used by masons and carpenters to find whether the surface is horizontal or not?
5. How are the wells which are forced out from the low level pits of the earth called?
6. Name the device that is used to transfer water from a higher level to the lower level.
7. Will a siphon work in vacuum? Explain.
8. How should the two limbs of a siphon be constructed?
9. What apparatus is used to separate the immiscible liquids which are in the same vessel?
10. What type of arrangement is made in the flush out tanks for automatic flushing?

(C) **Answer the following questions in one or two sentences:**

1. What is matter?
2. What are fluids? Why are they called so?
3. Mention the important properties of liquids.
4. What is the use of the water level?
5. How is a spirit level used?

6. What is an Artisian well? Why is it called so?
7. What is the basic principle of the Artesian well?
8. What is a siphon?
9. How does a safety siphon differ from an ordinary siphon?
10. What are the conditions for the working of the siphon?
11. For what purpose the safety Siphon is used?
12. How can the bad odour or poisonous gas from the flush out latrines be prevented from entering into the house?

(D) **Answer the following:**

1. Describe the experiment to prove that the water finds its own level.
2. How do the land surveyors measure the difference between the elevation and depression of the land surveyed?
3. How do you find whether the surface of a table is horizontal or not by using a spirit level?
4. Explain the construction of a siphon with the help of a diagram.
5. Explain how the siphon works.
6. What are the uses of the siphon?
7. Explain the working of the tantalus cup.

Exercise

1. Make use of the spirit level and verify whether the surface of the table in your class room is horizontal.
2. Make use of the lotus stalk as a siphon to transfer water from the higher level to the lower level.
3. Pour some amount of kerosene in a beaker. Then pour water in it. Now from this mixture separate kerosene.

12. AIR

What is Air?

What are you doing now? Now you are studying this science lesson. What is in between the book and your eyes? You may say 'Printed letters.' But there is something else between your eyes and the book. What is that?

Are there any trees around your class room? If you see any, observe them. Do the leaves of the trees move? How do they move? Find out what makes them move.

That which makes the leaves move is known as 'Air'.

What is air? Is it a solid, liquid or gas? Does it have any colour?

The air is around us everywhere. But we do not see it; we do not taste it; we do not smell it. But

we sometimes forget even its presence even though we are surrounded by air.

When do we notice the air? While running, while riding a bicycle, while travelling in a car or a bus, we feel the presence of air. During the day time in summer, we feel the hot air, and in winter we feel the cold air.

Air is a colourless gas.

Air covers the earth like a blanket. The air extends upto a a height of 240 km. This is known as the atmosphere.

Necessity of Air

1. Air is a mixture of several gases. It contains oxygen which is essential for life.

The astronauts found that there were no living beings on the moon. What is the reason for this? There is no atmosphere (air) on the moon. So it is not possible for the living beings to live on the moon.

To prove that it is not possible for the living beings to live without air (oxygen) the following experiment is done:

Experiment

A mouse is kept inside a bell jar. The air is totally removed from it by using an exhaust pump. When the air is removed, the mouse will die after some time.

From this we understand that the air is absolutely necessary for life.

2. Air is also necessary for combustion. When a substance burns, oxygen present in the air aids combustion. As a result the oxide of the substance is obtained.

Properties of Air

1. Air occupies Space

As air is a substance in gaseous state, it occupies space and has volume. We can prove it by an experiment.

Experiment

Let a glass flask be taken. Let its mouth be closed with a two holed rubber stopper. A glass

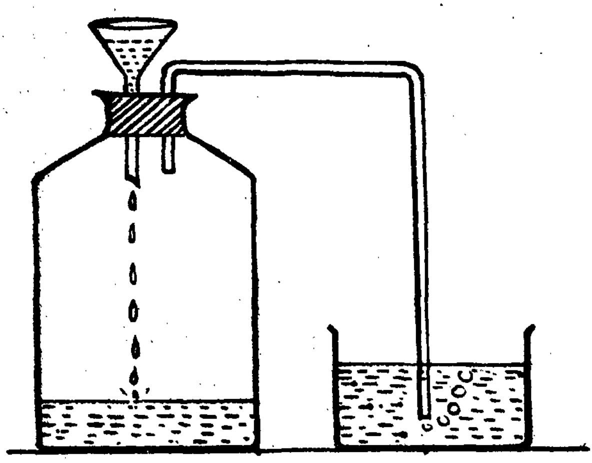


Fig. 59. Air occupies Space

funnel is fitted into the first hole and through the other a bent delivery tube is inserted. The other end of the delivery tube is immersed in a beaker of water.

Now some amount of water is poured through the funnel. Observe what happens? Water enters the flask slowly. At the same time air bubbles come out through the other end of the delivery tube which is immersed in water.

That is, certain amount of air, equal to the volume of water comes out of the flask.

By this experiment, we learn that air not only occupies space, but it has volume also.

2. Air has weight

If we say that air occupies space, then it must have weight like solids and liquids.

To prove that air has weight, a balloon is taken. The weight of the balloon is weighed before and after it is filled with air. The difference between the two weights gives the weight of air in the balloon.

We can find out the weight of air accurately from the following experiment:

Experiment

A glass flask is taken with a little amount of water in it. Its mouth is closed with a one holed rubber stopper. A small glass tube is inserted into it. A small rubber tube is fitted to the glass tube. A clip is attached to the rubber tube so as to close or open it whenever necessary.

The flask is kept on a metal stand over a wire gauze. The clip is opened. The water in the flask is heated with a spirit lamp. (Warning: Do not

boil the water in the flask without opening the clip). When the water boils, the steam leaves through the rubber tube. The air above the surface of water is pushed out by the escaping steam. Stop heating and then the clip is closed. The flask is taken out and checked whether the connections are airtight or not.

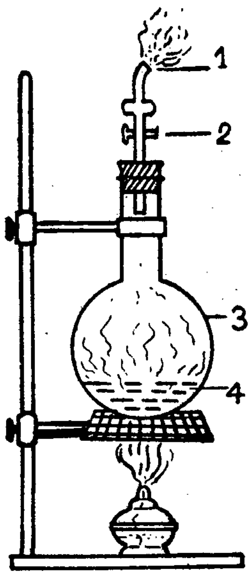


Fig. 60. To find the weight of air
1. Rubber tube
2. Clip
3. Glass flask
4. Water

After the flask is well cooled, the steam inside the flask condenses into water. The outside of the flask is wiped clean and its weight is found correctly.

Then the clip is removed. The air enters the flask. Now the weight of the flask with air and water is found. The difference between the two weights is also noted. This difference will indicate the weight of air which is inside the flask.

3. Air has Pressure

We have already learnt that air has weight. It also has pressure. Bodies exert pressure on other bodies because of their weight.

We can prove that air exerts pressure by the following experiment:

Experiment 1.

A thin cylindrical container is taken. It is closed with an airtight screw cap. Water is taken

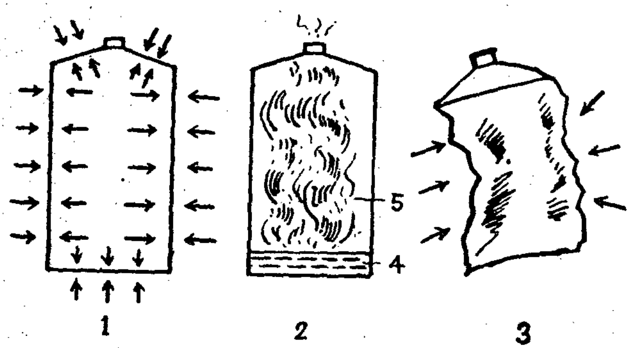


Fig. 61. Air has pressure *in all directions*

1. The *container with air* 2. The water in the container heated
3. The container is crushed 4. Water 5. Steam

filling half of the tin and it is kept on a stand. The water in it is heated to boiling point of water. While heating, the screw cap is removed. As the water boils, steam escapes through the opening. After the steam has escaped, the screw cap is closed tightly and heating is stopped.

Then some cold water is sprinkled on it. What will happen then? The tin container is distorted out of shape with an explosive sound. What is this due to?

When the water boils and the steam escapes, the air above the surface of the water is expelled completely. When the cold water is sprinkled on it, the steam in the container condenses into water.

Therefore low pressure is created inside the container. The air surrounding the container has pressure and it exerts pressure on the tin on all sides and as a result the tin is distorted.

From this we understand that the air exerts pressure.

Experiment 2

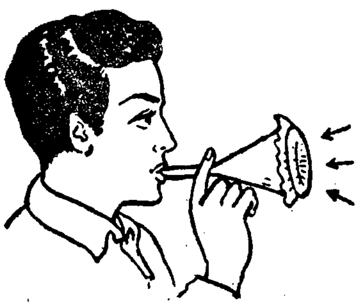


Fig. 62. Air exerts pressure in all directions

The broad end of a funnel is covered with a rubber sheet and it is tied tightly over it. The end of the tube is kept in the mouth and the air inside the funnel is sucked. Observe what happens. The rubber sheet is drawn in and it appears concave in shape. What is the reason for this?

The pressure of air inside and outside the rubber sheet remains the same before the experiment. It was equal to the atmospheric pressure. After sucking the air from the funnel, the pressure inside has become less. But at the same time pressure outside is becoming greater than the pressure inside and as a result the rubber sheet is pushed inside.

After sucking the air out, the tube end is closed tightly with the finger. Then the funnel is removed from the mouth and the broad end is held in differen

directions. Is any change found in the rubber sheet?

When the broad end is held, in any direction there is no change in the concave shape. Therefore we understand that the pressure of air is the same in all directions.

The air in the atmosphere exerts pressure on us from all directions. But we do not feel it. Why?

The pressure of air inside and outside our body is the same and so we are unable to feel the pressure of air outside the body.

Some Instruments that work with Atmospheric Pressure

(i) The Ink Filler

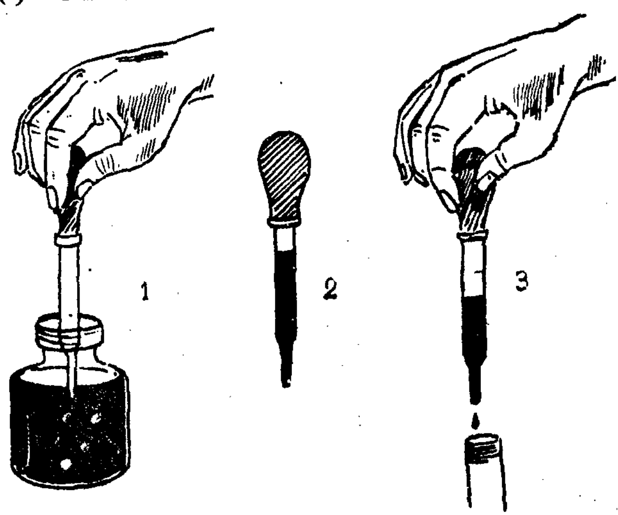
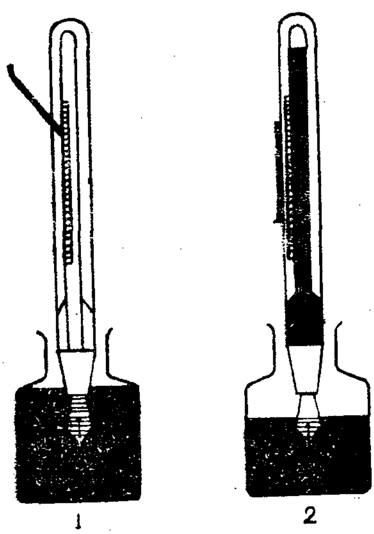


Fig. 63. The Ink Filler

1. Air is expelled when the rubber bulb is pressed 2. Ink rises in the tube. 3. Ink is expelled when the rubber bulb is pressed

The ink filler is made of glass or plastic. The tube is drawn into a jet at one end and there is a rubber bulb attached to the other end.

The jet end is kept in the ink bottle and the rubber bulb is pressed. As it is squeezed, air bubbles escape through the ink. Why? When the bulb is squeezed, the air inside is compressed and it escapes. So the air bubbles escape through the ink. Now the air pressure inside the bulb is reduced. When the bulb is released, the air on the surface of the ink exerts pressure and pushes ink into the tube. The ink filler is removed from the bottle and the jet end is kept at the mouth of the barrel of the pen. The bulb is pressed again, the small amount of air inside is compressed and it exerts pressure on the ink and it flows into the barrel of the pen.



Self-filling Pen

We fill the ink in the barrel of a pen by the ink filler. But in some kinds of pens, the ink filler is fitted to the pen itself. They are called self-filling pens.

Fig. 64. Self-filling pen 1. The lever is lifted and the rubber barrel is pressed. 2. The lever is brought back to its original position

In this kind of pen there is a rubber tube whose one end is closed at the bottom. The open end of the rubber tube is connected to the neck of the pen. There is a long metallic strip which helps to squeeze the tube. There is a lever arrangement attached to the barrel for squeezing the tube. The lever can be raised or lowered easily.

To fill the pen, the neck of the pen is kept in the ink and the lever is raised. The rubber tube is pressed by the long metallic strip. Therefore the air inside the tube is pushed out and it bubbles through the ink. So, the pressure of the air in the rubber tube is reduced. When the lever is lowered, the rubber tube expands. The higher atmospheric pressure outside forces the ink into the tube.

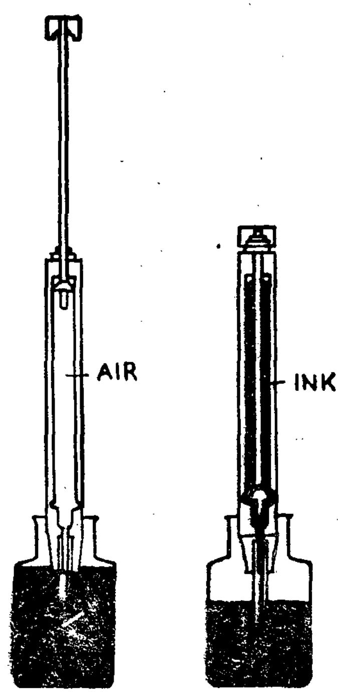


Fig. 65.
Filling the ink with the help of piston

Filling the Pen with the help of the Piston

In certain pens, there is a piston rod which can move forward and backward in the barrel.

This piston rod is moved backward and the neck of the pen is held in the ink bottle. Then the

piston rod is pushed forward. Now the air inside the barrel of the pen is forced out. At this state, the pressure inside is reduced and the atmospheric pressure outside is greater than the pressure inside. So it forces the ink into the pen.

Compressed Air

Three quarters of a glass tank is filled with water. An empty glass tumbler is held upside down vertically on the surface of the water and it is pushed down. Observe what happens. There is air inside the tumbler. The air occupies the entire space inside the tumbler and so water cannot enter it. The tumbler is pushed inside. Now the water level rises a little in the glass tumbler. What do we understand from this? It is possible to compress air to some extent and to reduce the volume of the air. Due to its reduction in volume, a little amount of water enters the tumbler. It is not easy to push the tumbler in. What is the reason for it? It is possible to compress the air only to some extent.

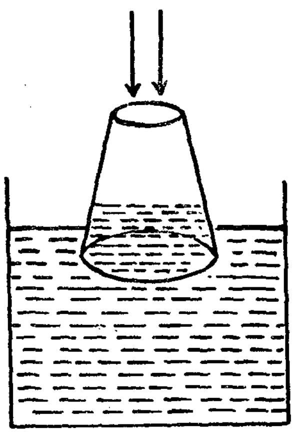


Fig. 66. Compressed Air

What will happen when the tumbler is released? The tumbler comes up with a certain force. That is, we understand that the air in a compressed state exerts force.

When the force which is responsible for compression is removed, the air expands with a certain force. Hence the tumbler is pushed out with an explosive sound.

Uses

Compressed air is used in air guns to force the bullet out. When compressed air is made to expand in a uniform manner, the force obtained can also be uniform. The same property is used to construct the air brakes in motor cars and buses. Moreover, when compressed air is allowed to expand suddenly, its temperature falls. This principle is applied in the refrigerators.

QUESTIONS

(A) **Fill up the blanks in the following questions:**

1. The air is a colourless ————————.
2. There is no living being in the moon because there is no ————————.
3. The air occupies ————————.
4. If the air is pressed, its ———————— is reduced.
5. When the compressed air expands, the ———— ———————— decreases.

(B) **Answer the following questions in one or two words:**

1. Name the mixture of different gases.
2. Mention any two devices on the atmospheric pressure.

3. Name the devices that are constructed on the basis of the force released from the compressed air.
4. What type of devices are constructed based on the principle of reduction in temperature of compressed air due to sudden expansion?

(C) **Answer the following questions in one or two sentences:**

1. What is air?
2. How do you feel the presence of air around us?
3. What is atmosphere?
4. The air is quite essential. Explain.
5. Why do we say that air is important for life?
6. Mention the properties of air.
7. How will you prove by a simple experiment that air has weight?
8. Even though air exerts pressure on us, we do not feel it. Why?
9. What are the properties of compressed air?
10. What are the uses of compressed air?

(D) **Answer the following:**

1. Describe an experiment to find the weight of air accurately.
2. Describe an experiment to prove that air exerts equal pressure in all directions.

3. How do you prove that air has upward and downward pressures?
4. Explain how the ink filler works.
5. Draw a diagram and explain how the self-filling pen works.
6. How do you prove that the compressed air exerts a greater pressure?

Exercise

To know the upward pressure of air, fill a glass tumbler with water. Close it with a thin cardboard. Press it with hands and hold the tumbler with water upside down. The cardboard does not fall. Water also does not fall. Why?

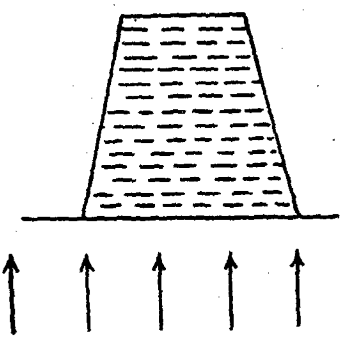


Fig. 67.

III. HEAT

13. THERMOMETERS

What is Heat?

When you go to school in the morning, you feel the heat of the sun. Without the sun, there is no heat. We feel the warmth by our senses and this is known as sense of hotness. This is also called heat. We get most of the heat energy from the sun naturally. We can also produce heat artificially by burning fuels-coal, gas and oil, by using electricity, by way of chemical changes, by friction, by pressure and by radioactivity. Thus we can produce heat in several ways as mentioned above.

Hence heat is a form of energy.

Effects of Heat

Heat energy produces more effects. When a body gains or loses heat, it undergoes many changes. These changes are:

1. change in temperature
2. change of size
3. change of state
4. chemical change
5. electrical change.

Heat and Temperature

An object kept in sunlight is hot and ice is cold. How do we say this? We say this by touching the objects.

When we touch the hot object, the heat from that body passes on to our body. So we feel that it is hot. So also when we touch ice, the heat from our body is transmitted to that object. As a result we feel that it is cold.

We know that, heat has a property of flowing from one object to the other nearby and the hot object transfers heat to the cold object.

So heat is a form of energy. Heat is the cause and temperature is the effect.

Thermometers

It is impossible to say whether an object is hot or cold by mere touch.

Three vessels are taken. In each of these, hot water, tepid water and cold water are taken.

First dip the fingers of your right hand in the cold water and also the fingers of your left hand in the hot water. How do you feel? The fingers of your right hand feel the coldness of the water and fingers of the left hand feel the hotness of the water. Both hands are removed simultaneously and now they are dipped in the warm water in the third vessel. Now how do you feel? The fingers in the left hand give the impression that the water is cold and those of the right hand give the impression that the water is

hot. Although both the hands are kept in the warm water the feeling is different.

From this we can conclude that it is not possible to estimate the temperature of another body even approximately by the sense of touch.

We all know that the rock that is exposed to the sunlight, the glowing fire in the oven, the red hot metal in a furnace are hot. But they do not have the same degree of hotness. The quantities of heat energy in the three objects vary and so their temperatures vary. How do we determine the temperatures of objects?

To know the temperature of a body, a thermometer is used. Thermometers are of different kinds. Generally, we make use of the mercury-in-glass thermometers to measure the temperature. In the thermometers we measure the temperature by means of the expansion of mercury.

The Celsius thermometers are used mostly in the laboratories. Fahrenheit thermometers may also be used.

Units of Temperature

To measure the temperature, the unit 'Celsius' is used in the Metric system. It was called 'Centigrade' previously. This was devised by a scientist named Anders Celsius and so it is named after him.

In British units, Fahrenheit is used as the unit of measurement of the temperature.

In the *SI* Kelvin is used as the unit of measurement of temperature.

Construction of Thermometers

An ordinary thermometer is made of thick glass. Inside a capillary tube runs through the length of the glass tube. The lower end of the tube is shaped like a bulb. Some amount of mercury is held in this bulb. The glass tube is graduated either in the Celsius scale or in the Fahrenheit scale. The first graduation mark corresponds to the melting point of ice and the last to the boiling point of water. The temperature at which the ice melts or the melting point of the ice is called the lower fixed point and the temperature at which water boils or the boiling point of water is known as the upper fixed point respectively.

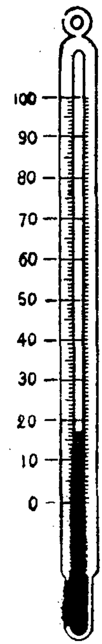


Fig. 68. Celsius Thermometer

In the Celsius thermometer, the lower fixed point is 0° Celcius (0°*C*) and the upper fixed point is 100°*C*. In the Fahrenheit thermometer the above measurements are 32° *F* and 212° *F*. respectively.

If these thermometers are used for finding the temperature beyond the boiling point of water, the thermometer will be damaged.

There are different types of thermometers to measure the temperatures higher than the boiling point of water and lower than the freezing point of water.

Reasons for using Mercury as the Thermometric Liquid

Why do we use mercury in thermometers? There are many reasons for this. They are:

1. Mercury is a shiny and opaque metal in the form of liquid.
2. It does not wet or stick to the glass tube of the thermometer.
3. It easily conducts heat. So it attains the temperature of the objects easily.
4. It expands uniformly at all temperatures.
5. Its specific heat capacity is very low. Hence it does not take more heat to attain the temperature of a body.
6. Its freezing point is —39° C. Its boiling point is 357°C. It is solely used for finding the ordinary temperatures lying between these two.

In clinical thermometers, the Fahrenheit scale is used.

Comparision of the Celsius scale with the Fahrenheit scale

The upper fixed point is 100°C in Celsius scale and it is equal to 212°F in Fahrenheit scale. The lower fixed point is 0°C and is equal to 32°F in the Fahrenheit scale.

It is possible for us to convert the Celsius scale of temperatures into the Fahrenheit scale of temperatures and vice versa.

100 Celsius divisions $=$ 180 Fahrenheit divisions

$\therefore$ 1 Celsius division $= \frac{180}{100}$ " "

$= \frac{9}{5}$ " "

For example,

25 Celsius divisions $= \frac{9}{5} \times 25 = 45$ Fahrenheit divisions.

If we add $32°F.$ to $45°F.$ divisions, the resultant temperature is $(45 + 32) = 77° F.$

$\therefore \quad 25° C = 77°F.$

$$\therefore F = (C \times \frac{9}{5}) + 32$$

Thus Celsius scale is converted into Fahrenheit scale.

$$C = (F—32) \frac{5}{9}.$$

By using the above relation, Fahrenheit scale is converted into the Celsius scale.

Conversion of the Celsius Scales of Temperature to Kelvin Scale of Temperature

0° Celsius $=$ 273 Kelvin.

$\therefore K = C + 273.$

For example, to convert $30°C$ into Kelvin,

$K = 30°C + 273 = 303°K$

$\therefore 30° C = 303 \ K.$

QUESTIONS

(A) Fill up the blanks in the following:

1. Heat is one kind of ——————.
2. To measure the temperature the unit Celsius is used in the metric system and —————— is used in the *SI*.
3. The liquid mostly used in thermometers is ——————.

(B) Answer the following in one or two words:

1. Which gives us heat energy mostly in nature?
2. Why is the Celsius scale of temperature called so?
3. What is the use of thermometers?
4. Mention the lower and upper fixed points in the Celsius thermometer.

(C) Answer the following in one or two sentences:

1. State the effects of heat.
2. Differentiate between heat and temperature.
3. Explain: lower fixed point and upper fixed point.

(D) Answer the following:

1. State the reasons for using mercury in thermometers.
2. Explain with a neat diagram the construction of a thermometer.

Problems

1. Let the temperature of your room be $24°C$. Convert it in to the Kelvin scale.
2. Convert $80° C$ into Fahrenheit scale.
3. One has fever with $102° F$. Convert the same temperature into the Celsius scale.
4. Liquid nitrogen boils at $77\ K$. Convert it into the Celsius scale.

14. EXPANSION DUE TO HEAT

When heat is transmitted to a body it undergoes many changes. One type of change is the 'change in size' of the body. Now let us consider this.

What is meant by 'change in size'? It means the expansion of a body in its size, that is, in length or in area or in volume due to heat.

When we find the rise in temperature of a body with the thermometer we measure it with the expansion of mercury. Hence bodies expand due to heat.

Expansion of Solids

Solids expand due to heat. To prove this 'the ball and ring' apparatus is used.

It consists of a metallic ball and ring. The ball easily enters the ring. The metallic ball is heated by a spirit lamp. After heating it try to push the ball into the ring. It does not enter

it easily now. It rests on the ring. What is the reason for this? Due to heat the ball has expanded and has undergone a change in its volume

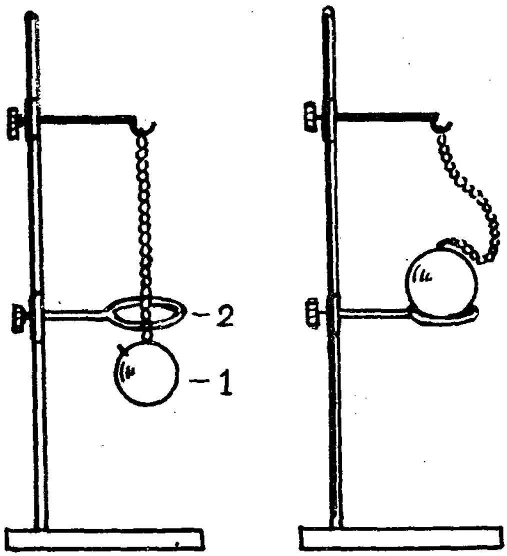


Fig. 69. Expansion of solid due to heat
1. Metallic sphere 2. Ring

So it does not enter the ring easily. When the ball is cooled and is pushed again, it enters the ring. Why?

The property of expansion of solids due to heat is useful in many ways in our daily life.

(i) A gap is left between the junction of two iron rails while they are joined together. Why? In summer the rails expand in length due to heat. So sufficient space is left in between the rails taking into consideration the above expansion.

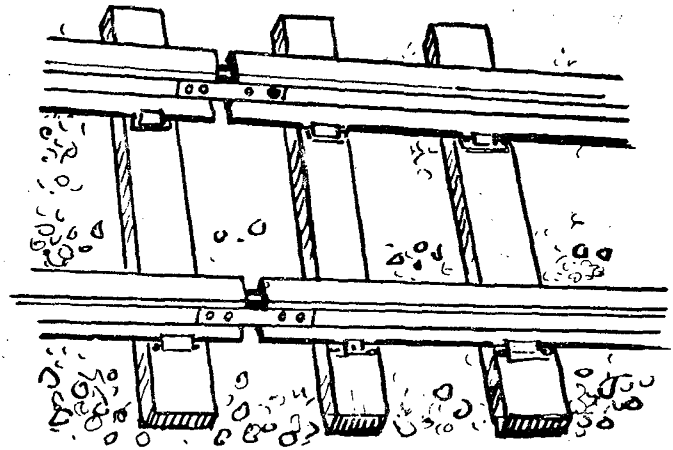


Fig. 70. Expansion of iron-rails

(ii) When the metallic cap of a bottle or the neck of the pen is too tight to be unscrewed. what do you do? If that portion is heated a little it is possible to unscrew it without much effort. What is the reason for this?

(iii) How are the iron rims fixed over the wooden wheels of carts? The perimeter of the iron rim is made slightly less than the circumference of the wheel and it is heated strongly. In the expanded state, the iron rim is fixed on the wooden wheel. Then cold water is poured on it. After cooling, it contracts in length (circumference) so that it is fixed very tightly on the wheel.

We understand that solids expand due to heat and they contract if the temperature decreases.

Expansion of Liquids

Liquids also expand due to heat. Solids expand in length, in area and in volume but liquids expand in volume only. Why?

We can learn about the expansion of liquids from the following experiment:

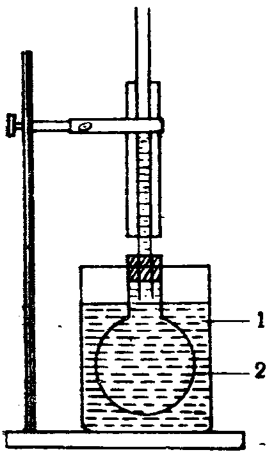


Fig. 71.
Expansion of liquid due to heat
1. The vessel with hot water
2. The flask with cold water

A glass flask is taken and filled with water which is coloured with red ink. The mouth is closed with a one holed rubber stopper. A long glass tube is inserted into the stopper. Now the water in the flask rises to some extent in the tube. The flask should be completely filled with water without air bubbles.

A big beaker is taken and half filled with water and the glass flask is kept in it. The flask is heated with a spirit lamp. Initially the level of water in the glass tube falls. Why? When it is heated the flask expands initially and so the water level falls. Then water expands and the level of water rises in the tube and overflows.

This property of expansion of liquids is used in thermometers.

Expansion of Gases

Solids expand due to heat in length, area and volume. Liquids expand in volume only. But what about gases?

Blow the air in a rubber balloon and heat it slightly. Observe what happens. Its volume increases and the balloon expands to a certain extent.

What is there inside an empty glass flask? Air. Close its mouth tightly and heat it. Observe what happens. Does the volume of the enclosed air increase? No, It does not increase. Instead the pressure of air increases and it presses the walls of the flask vigorously. If it is heated further, the pressure increases and the flask bursts into pieces.

So, if a gas is heated it expands i.e. its volume and pressure increases.

Liquids expand more than solids due to heat. But gases expand the most due to heat.

We can understand the expansion of gases from the following experiment:

Experiment

A dry glass flask is taken. Its mouth is closed with one hole d rubber stopper. A long glass tube is inserted into it. It is inverted with the tube and fixed in a stand. The tube is kept immersed in a beaker with water coloured with ink. The flask is heated. The air inside the flask expands and bubbles escape through the water in the beaker. Then the heating is stopped. Now the

air inside the flask cools and it contracts. The water rises up into the tube. Now we understand by this experiment that the gases expand due to heat and contract when the temperature decreases.

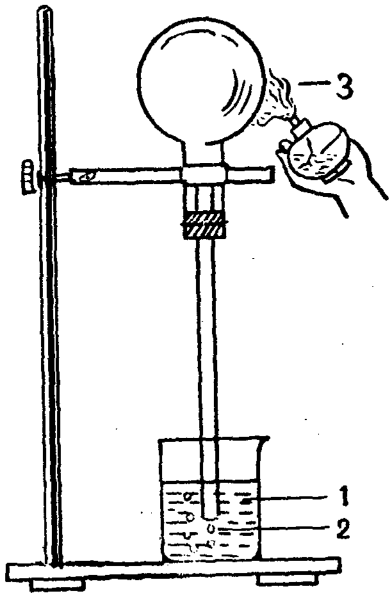


Fig. 72.
Expansion of gas due to heat
1. Water
2. Air bubbles
3. Flame

This sort of arrangement was first made by **Galileo,** and he used it as a thermometer. This is known as the Galilean thermometer. This can indicate even a slight difference in the temperature. To measure accurate measurements the scales may be marked on the glass tube itself.

QUESTIONS

(A) Fill up the blanks in the following:

1. The objects expand due to ________________.

2. With the reduction in temperature, the objects__________ in size.

3. The property of expansion of liquids due to heat is used in ——————.
4. If a gas is heated it expands in —————— and ——————.

(B) **Answer the following question in one or two words:**

1. Name the device that shows the expansion of solids due to heat.
2. Name the states of matter which show (a) maximum expansion and (b) minimum expansion when heated.
3. Who used the principle of expansion of gas as a thermometer?

(C) **Answer the following in one or two sentences:**

1. What is change of size due to heat?
2. Why is a gap left between any two iron rails?
3. What is the reason for fixing a hot iron rim over the wooden wheels of carts?
4. How do we open the metallic cap of a bottle which is too tight?
5. Why do the liquids expand only in volume due to heat?
6. What is 'Galilean thermometer'?

(D) **Answer the following:**

1. Describe an experiment to prove that a solid expands due to heat.

2. How will you prove that a liquid expands due to heat?
3. How will you prove that gases expand due to heat?

For Thought

1. When you sprinkle a few drops of cold water on the hot bulb of a lamp, the glass cracks. Why?
2. The expansion of liquids is not real expansion. Why?

Exercise

Take an empty glass bottle. Fix the mouth of a balloon to the neck of the bottle. Wrap your fingers around the bottle after rubbing the palms of your hands. Is there any change in the balloon? Why?

15. CHANGE OF STATE

As objects expand due to heat, they undergo a change of state also. What is meant by a change of state?

Matter is found generally in three states. They are solids, liquids and gases.

Whatever be the state in which matter exists it occupies space. It has weight and volume also.

Metals like gold, iron, and copper and materials such as carbon, sulphur, salt and ice are examples of solids.

Objects like water, mercury, kerosene etc., are examples of liquids.

Steam, oxygen, nitrogen, carbon- di- oxide etc., are examples of gases.

When a metal, say, gold is heated, it melts and becomes a liquid. Likewise liquids are converted into gases when heated.

Thus an object which is changed from one state to another is said to be undergoing a change of state. For this purpose heat energy is used.

Melting and Evaporation

For example, let us consider ice.

What will happen if ice is kept at room temperature. It melts into water which is in the liquid, state. That is, ice changes from the solid state into water in the liquid state. If water is poured into a glass beaker and heated it gets warm, boils and changes into steam. Now water changes from the liquid state to steam in the gaseous state.

	Ice	⟶	Solid
(Melting)	↓		↓
	Water	⟶	Liquid
(Evaporating)	↓		↓
	Steam	⟶	Gas

Condensation of Vapour and Freezing

If the temperature is reduced slowly, the changes occur in the reverse order.

If steam is cooled, that is, if the temperature is reduced — the vapour condenses into water. If water is cooled more and more, it freezes into ice.

Gas	←	Steam
↓		↓ (Vapour Condensation)
Liquid	←	Water
↓		↓ (Freezing)
Solid	←	Ice

Cooling of Gases

It is possible to change many gases into liquid state by condensation. By this, the gases occupy more volume and when changed into liquids they occupy less volumes.

Gases like oxygen and nitrogen are cooled and so they become liquids. The temperatures of such liquids are far below the temperature of ice.

For example the temperature of ice is 0°*C*. The temperature of liquid oxygen is—183°*C*. i.e. the temperature of liquid oxygen is lower than the temperature of ice by 183 degrees.

If carbon dioxide in the gaseous state is cooled it changes into liquid easily. If it is cooled more and more it freezes and becomes solid. Solid carbon dioxide is known as 'dry ice'.

Mercury can be solidified at a very low temperature. The freezing point of mercury is—39°*C*.

When an object undergoes change of state, there will be change in size and volume. But no change takes place in weight (mass). It is constant.

QUESTIONS

(A) Fill up the blanks in the following questions:

1. For change of state of a body ——————— energy is used.
2. Water is known as ————— in the solid state and ————— in the gaseous state.
3. The temperature of liquid oxygen is ———————.
4. Solid carbon dioxide is known as ———————.
5. The temperature of frozen mercury is ———————.

(B) Answer the following questions in one or two words:

1. What are the three different states of matter?
2. Give two examples for solids.
3. Give two examples for liquids.
4. Give two examples for gases.
5. Mention the name of the liquid form of ice.

(C) **Mention the type of change of state in the following:**

1. Melting of iron in a furnace.
2. Water boils in a boiler.
3. Manufacture of ice.
4. Manufacture of liquid oxygen.

(D) **Answer the following questions in one or two sentences:**

1. What is change of state?
2. What is meant by melting?
3. What is evaporation?
4. What is condensation?
5. What is 'freezing'?

(E) **Answer the following:**

Explain with an example that matter can exist in three states.

Exerci e

1. Take two pieces of cloth. Soak one of them in water and the other in kerosene. and allow them to dry in the air. Which dries quickly? Why?
2. You like to taste ice very much. Why do you not make the ice?

You can prepare the ice with milk.

Take some amount of sugar and mix it with hot milk and cool it. Buy some ice from the shop.

Make it into small pieces and mix it with common salt. Keep the mixture in a wooden box (Chalk box). Ask for some test tubes from the laboratory and pour some milk into them. Then fill the test tubes with milk and keep it vertically in the mixture of ice and salt. Insert wooden sticks into each one of the test tubes so as to remove the ice easily. After some hours, the milk will freeze into ice milk. The icc in the test tubes can be taken out carefully and tasted.

16. TRANSMISSION OF HEAT—CONDUCTION OF HEAT

Transmission of Heat

Bodies expand due to heat energy. They also attain change of state. Change of temperature also takes place. The heat passes from an object at a higher temperature to an object at a lower temperature. Thus the transfer of heat from one body to another body is known as transmission of heat.

Methods of Transmission of Heat

Take some water, boil it and pour it into a vessel. After boiling take the vessel with your hands. How do you feel? Oh! You cannot bear the heat of the vessel. Why?

You have boiled the water only. You have poured it into a vessel and you have not heated the vessel.

When you boil the water you give the heat only at the bottom of the vessel. But the water on the surface gets heated. How does this happen?

You walk under the hot sun. You feel very hot. There is only atmospheric air and then empty space between you and the sun. How does the heat from the sun at a very great distance of several millions of kilometres affect you?

Heat is transferred in three ways. They are by (i) Conduction (ii) Convection and (iii) Radiation.

Conduction of Heat

What is meant by conduction of heat?

When boiled water is poured into a vessel the heat is conducted from the water to the vessel. How?

Suppose your teacher gives you a book. You give it to the next boy, he passes it on to the next boy and like this the book is passed from hand to hand. At last the book reaches the last boy. In other words the book is 'conducted' from the teacher to the last boy in the class.

Substances are made of molecules. While heating, one molecule conducts the heat to the other molecule and so on. Thus all the molecules conduct the heat energy and the substance gets heated.

After pouring boiling water into the metallic vessel, there is contact between the molecules of water and the molecules of the vessel and the heat energy is conducted from water to the vessel.

The process by which the molecules transfer the heat energy without moving or changing its position is known as conduction of heat.

Conductors of Heat

Does the conduction of heat take place in different substances in the same manner?

Pour the hot milk into a metallic vessel and hold it with your hands. Pour the same in a glass tumbler and hold it. Is there any difference between the two?

Different substances conduct different amounts of heat. According to their capacity of conducting heat, the substances are divdided into (i) good conductors and (ii) bad or poor conductors.

Substances which conduct heat easily are known as good conductors. Metals like iron, copper etc., alloys like brass, are examples of good conductors.

Substances which conduct heat with difficulty are known as bad conductors. Glass, ceramics, air, water, wood, plastic etc. are examples of bad conductors. They protect us from heat and they are also known as insulators.

Conductivity of Metals

(i) Metals are good conductors of heat than other substances:

A cylinder made of half metal and half wood is taken. A white paper is wrapped tightly around

it and pasted. It is heated by the flame of a spirit lamp. Observe what happens. Does the paper burn?

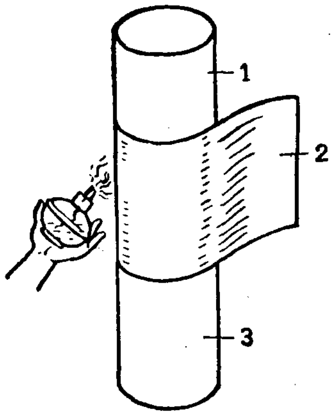


Fig. 73.
Conductivity of Metal

1. Metal
2. Paper
3. Wood

The paper covering the wood chars. But the paper covering the metal does not char. Why?

The heat obtained from the flame is conducted easily by the molecules of metal. Hence the heat is not conducted much to the paper. Moreover the wood is a bad conductor of heat and so it conducts heat slowly. Hence the paper covering chars quickly. Thus we understand that the metals conduct heat quickly than other substances.

(2) **Different metals conduct heat differently**

A big metal trough is taken. At one of its sides near its bottom, four holes are made at equal distances. The holes are closed with four one holed rubber corks. Four cylindrical rods made of aluminium, copper, lead, iron are inserted into each of these holes. Before inserting these rods, they should be dipped in molten paraffin wax. A thin layer of molten wax covers the metal rods.

Boiling water is poured to half of the trough. After some time wax on the metals start to melt.

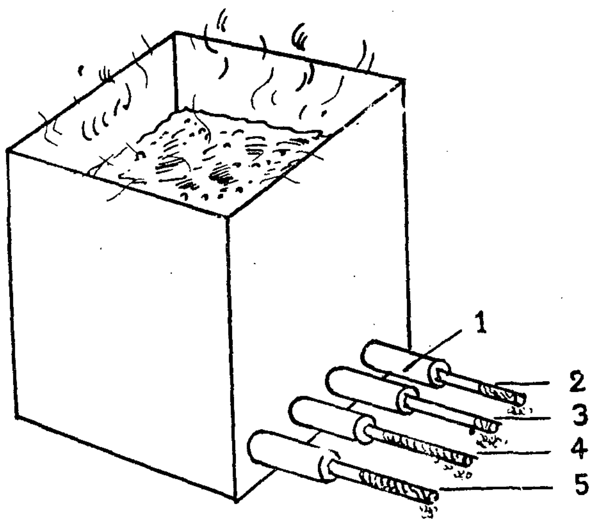


Fig. 74. Different metals conduct heat differently

1. Rubber Cork 2. Aluminium
3. Copper 4. Lead 5. Iron

But the melting takes place to various distances of the metal rods.

The distance to which wax has melted on the copper rod is the longest and next comes aluminium, and next iron and last lead.

What is the reason for this? This is because different metals conduct heat in different amounts.

The Bunsen Burner

Take a bunsen burner. A copper wire gauge is placed about 5 cms. above the burner and the gas

is turned on. The gas is lighted above the wire gauze. The flame burns above the gauze. But the gas does

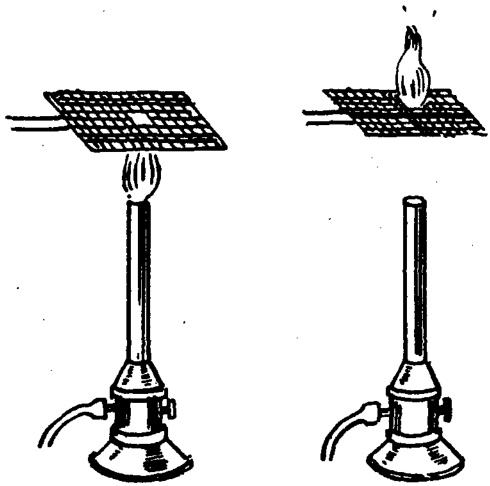


Fig. 75. Burning of the Bunsen Burner

not burn below the gauze. Why? The wires conduct heat rapidly as it is a good conductor of heat. So the heat does not pass underneath the gauze.

The gas is now closed and the wire gauze is allowed to cool. Then the gas is again turned on and lit underneath the gauze. The gas burns underneath only. Above the gauze it does not burn. The reason for this is that the wire gauze conducts the heat.

This principle is applied in the safety lamps which were once used in the mines.

Davy Safety Lamp

Men dig several mines and they have to work inside these mines. They take lamps with them because

of the darkness in the mines. Inside the mines are inflammable gases like 'methane'. If oil lamps are taken inside the mines, the inflammable gases will cause fatal accidents.

How can this be prevented?

Sir Humphry Davy, a scientist found a solution to this problem in the year 1813.

He invented and perfected a special safety lamp by using the property of heat conduction.

Davy safety lamp is also an oil lamp. But the flame is surrounded by a wire gauze. The heat of the flame inside will not reach the gas. The temperature for setting it on fire will not go beyond the wire gauze. From the colour of the flame inside, it can be known that some inflammable gases are present in the mines and thus the workers are cautioned. For example if the flame is in blue colour it indicates the presence of methane.

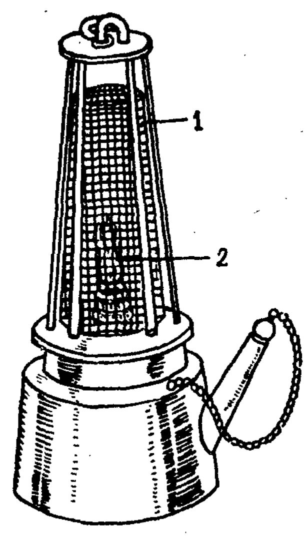


Fig. 76.
Davy Safety lamp
1. Wire gauze 2. Flame

Nowdays electric lamps are used mostly and so these types of lamps have become out of date.

Water is a bad conductor of heat

Generally all liquids except mercury and metals in the molten state and alloys are bad conductors of heat.

For example, it can be proved by the following experiment that water is a bad conductor of heat.

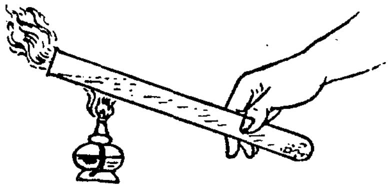


Fig. 77.
Water is a bad conductor of heat

A test tube is taken and its three fourths is filled with water. A small piece of wax may be tied with a small weight and it may be made to remain at the bottom of the test tube. The upper portion of water is heated by a spirit lamp. The water starts boiling on its surface. But the wax at the bottom of the test tube will not melt.

What do you understand from this?

It is clear that water does not conduct heat. So water is a bad conductor of heat.

Gas is a bad conductor of heat

Gases are bad conductors of heat and they conduct heat lesser than liquids.

An empty test tube is held in our finger as shown in Fig. 78.

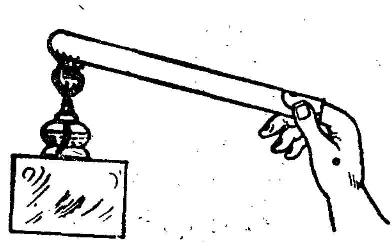


Fig. 78.
Gas is a bad conductor of heat

Its bottom is heated with a spirit lamp. If the heat is conducted by air, the hotness will be felt by the finger. But the finger does not feel the warmth. It will take more time for the finger to feel it.

From this we understand that the aii is a bad conductor of heat. Similarly the other gases are also bad conductors of heat.

Uses of the Conductors of Heat

Good conductois of heat are used to make utensils or vessels for cooking and boilers. By this, the heat is conducted and the cooking can be completed quickly. In boilers water boils quickly.

How do we handle these articles which conduct heat? Handles of such objects are made of wood or plastic which are bad conductors of heat.

To prevent ice from melting, saw dust which is a bad conductor of heat, is used.

Thermocole, a kind of plastic, is used as an insulating material to maintain the temperature of substances in ice boxes and of the ceiling in air conditioned rooms. Thermocole is a solid plastic foam which contains more vacuoles and resembles pith.

Insulating materials like glass wool, asbestos, pith or thermocole are used for lining between the inner and the outer walls of our houses, the railway carriages and motor cars.

As the aii which is a bad conductor is in between the inuer and the outer roof, the heat is prevented from getting in.

People wear woollen clothes during winter in order not to lose the body temperature and to feel warm.

Astronauts make use of special dresses made of special insulating materials in different layers to prevent them from feeling the intense heat or the bitter cold.

Firemen who are engaged in putting out fire make use of the dress that is made of absestos or glass wool which are bad conductors of heat.

QUESTIONS

(A) **Fill up the blanks in the following:**

1. In all the substances, conduction of heat ——————— in the same amount.
2. In vacuum, conduction of heat is ———————————.
3. Metals are ——————— conductors of heat.
4. The bad conductors of heat are called ———————————.
5. Different metals conduct heat in ——————————— amounts.
6. The inflammable gas which exists in the mines is ———————.
7. Of the liquids, mercury is ——————— conductor of heat.

(B) Name the good and bad conductors of heat in the following substances:

(1) Water (2) Iron (3) Thermocole (4) Saw dust (5) Mercury (6) Molten Aluminium (7) Plastic (8) Asbestos (9) Pith (10) Glass Wool.

(C) Answer the following questions in one or two words:

1. Name the three kinds of heat transfer.
2. How are the conductors of heat classified? What are they?
3. Give examples for good conductors of heat
4. Give examples for bad conductors of heat.
5. Name the scientist who invented the safety lamp which was used in the mines.
6. Mention the name of the substance that is kept on the ice to prevent it from melting.

(D) Answer the following in one or two sentences:

1. What is meant by transmission of heat?
2. What is the conduction of heat?
3. What is thermocole?
4. How is thermocole useful?
5. How is the heat prevented from getting in the roof of houses?
6. What is the reason for making the handles of the cooking vessels with wood?

7. Why do people wear woollen clothes during winter?
8. What kind of dress do the astronauts wear and why?
9. What kind of dress do the firemen wear and why?

(E) **Answer the following:**

1. How will you prove that the metals conduct heat quickly than the other substances?
2. How do you compare and contrast the capacity of the conduction of heat of the different metals?
3. Describe the conduction of heat taking place by means of a wire gauze in a bunsen burner.
4. Explain the construction of Davy safety lamp and what is its use?
5. How do you prove that water is a bad conductor of heat?
6. Prove by an experiment that the air is a bad conductor of heat.
7. State the uses of bad conductors of heat in our daily life.

For Thought

1. A barren floor is cold. But the floor on which a carpet or woollen cloth is spread is warm. Why?

2. It is better to use two thin clothes as a blanket than to use a thick cloth. Why?
3. The wooden handle of a metallic vessel is not cold but an iron one is very cold to touch. Why?
4. When you go by the side of a river under the hot sun and when you touch the surface of water it will be hot. But if you put your leg under the water you feel that the water below is cold. Why?

Exercise

1. Make a paper cup and take some water in it. Heat the water with a spirit lámp. Does the paper burn?
2. Take any metal rod. Dip it into molten wax. Above half of the portion fix drawing pins on the wax at equal intervals. Fix the metal rod horizontally on a stand and heat it at one of its ends. Does the heat melt the wax? Do the drawing pins fall at the same time? Try this.

17. CONVECTION OF HEAT

Convection

Liquids and gases are bad conductors of heat.

How is it possible for us to heat the entire quantity of water in a vessel? If water is a bad conductor

of heat, how is the heat transmitted from the bottom to the surface?

Suppose the teacher passes on a book to a boy in the last bench. He can pass it on from one student to another. Instead of transmitting it thus, the student himself can come to the teacher directly and receive the book. Likewise, the water at the bottom of the vessel gets heated. But it does not conduct the heat to the next layer. Instead, the heated water goes up and the cold water at the top comes down and gets heated.

How does the heated water go upwards and the cold water come down?

The substances are made of molecules. These molecules expand due to heat and they become light. The molecules at the top are heavy and so they move downwards pushing the light molecules upwards. This movement of the molecules goes on till the whole liquid gets heated.

When the heated particles move from one point to another, transmitting heat, it is known as convection of heat.

Convection of heat does not take place in solids. It will take place only in liquids and gases.

Convection of Heat in Liquids

We understand that the convection current takes place in liquids. Let us conduct an experiment to prove this.

Experiment

A glass flask is taken. Three fourths of it is filled with water. A little amount of saw dust is put under the water and the water is heated by a spirit lamp or a bunsen burner at the bottom where saw dust remain.

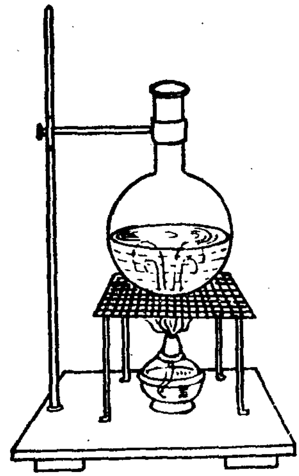


Fig. 79.
Convection of heat in liquids

What do you observe? When the water is heated it is seen that the saw dust rises up. When it rises upwards, it comes down along the side. Thus the molecules of water, when heated, go upwards and move downwards and this cycle takes place continuously and so we see the saw dust moving up and down in the water. Thus we understand that convection of heat takes place in the liquid.

Convection of Heat in Gases

The transmission of heat by means of convection is understood from the following experiment:

A long chimney is taken. A piece of cardboard in the form of 'T' is cut and inserted in it as shown in Fig. 80. Now the top portion is divided into two parts. A candle is lit in a dish containing water. The chimney is placed in the water. The candle burns well till the cardboard is there on the chimney.

As soon as the cardboard is removed, the candle is put out.

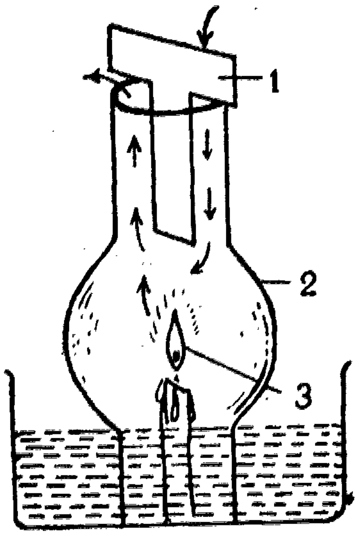


Fig. 80.
Convection of heat in gases

1. T–shaped card board
2. Glass chimney
3. Candle flame

The cardboard is again placed in the chimney and the candle is lit again. A smoking wick is placed near the top. The smoke enters through one portion of the divided part and gets out through the other portion.

Due to the burning of the candle, hot air which is light enters through one way and the heavy air at the top enters another way.

So we understand that heat transmission by convection takes place in gases.

Effects of Convection of Heat

(1) Ventilation in houses

It is necessary to have proper ventilation in our houses. The air exhaled by the human beings is hot. The hot air should go out. In its place fresh air must come in. For this, the doors and windows are located in such a way that they are facing each other. Hence the room will get proper ventilation.

In spacious houses, big cinema and drama theatres, there are ventilators or exhaust fans at the top. They send out the hot air exhaled by the people inside and help the fresh air to come in.

Likewise in factories, the large amount of smoke formed inside is sent out through tall chimneys. This is because of the convection of hot air.

(2) Chimney Lamps

How do the chimney lamps used in our houses burn? There are some openings near the place where the chimney is inserted. Why? Does it burn continuously if the top is closed? Is the oil alone needed for the wicks of the chimney lamps? Oxygen is also needed to burn. Very near the place where the chimney is inserted, there are some small openings provided for the outside air to come in through them. It gives oxygen for the burning. The heated air goes upwards. If the top of the chimney is closed, the convection is stopped and the wick is put out because the oxygen required for burning is not available.

(3) Sea breeze and Land breeze

During midday in summer, the land very near the seashore will be hotter than the sea, because the land is affected more by the heat of the burning sun than the sea. The air above the land becomes light and goes up while the cool denser air above the sea blows over the land. This is called 'sea breeze'.

During the night the land is cold. But the sea water is warm. So the air above the sea gets

heated, becomes light and goes upwards. Then the cold, denser air above the land blows towards the sea. This is called 'land breeze'.

(4) Monsoon

When do we get the sea breeze and land breeze? We get breeze from the sea during the day time and the land breeze during night.

When the seasons change, the appearance and direction of the air which blows also change.

During summer the large areas of land in Asia become warm. Consequently the north west parts of India also get heated heavily and experience very low pressure. At the same time the pressure increases on the surface of the ocean. Then the wind blows from the high pressure area to the low pressure area. Thus the South West monsoon blows over India during summer.

During winter the wind blows from the high pressure areas of the cold regions to the areas near the sea in the South which are at low pressure. This wind is known as North East monsoon.

Thus the monsoons sweeping over India are well set in and developed. The South West Monsoon blows in summer and the North East Monsoon blows in winter.

(5) Ocean Currents

Ocean currents are very good examples for the convection of heat.

The Indian Ocean is situated mainly in the hot areas near the equator and in the north and south of the tropical zones. The Pacific and the Atlantic oceans are very big.

The areas adjacent to the equator are heated by the sun and the heat produces convectional currents. The water of the ocean becomes light, moves at the level of its surface and this whirling of the warm water at its surface is called 'warm ocean current.'

The north Pacific and the North Atlantic currents prevent the areas which are naturally cold at freezing temperature from being frozen still further. Many cold ocean currents are observed in the big seas.

QUESTIONS

(A) Fill up the blanks in the following:

1. Heat transfer by convection occurs in ——— ——————— and ————.
2. In big auditoria ——————— are fixed at the top to get fresh air.
3. The air which blows from the sea towards the land is known as ——————— and the air, blowing from the land towards the sea is known as ——————————.

(B) Answer the following questions in one or two words:

1. Name the monsoons that blow over India.

2. State a good example for convection of current.

(C) **Answer the following in one or two sentences:**

1. What is 'Convection of heat'?
2. How does ventilation take place at home?
3. How does the burning of a wick takes place in the chimney lamps?
4. What are monsoons?
5. State how the sea breeze is caused.
6. State how the land breeze is caused.
7. How are the ocean currents caused?

(E) **Answer the following:**

1. Explain how you will demonstrate the convection of heat in water.
2. Describe an experiment to demonstrate the convection of heat in air.

Exercise

Cut out a spiral from a tinfoil or a thin cardboard. Fix it above a burning flame of a spirit lamp. You will see it going round and round. Why?

18. RADIATION OF HEAT

Radiation of heat

The molecules of a substance transfer the heat energy without changing its position and this is known

as conduction of heat. If the molecules move from one place to another and transfer heat, it is known as convection of heat. How is the heat transferred when it cannot be transmitted either by conduction or by convection?

We have already explained that the teacher can pass the book from his hand to the last boy through the other boys in between or the boy himself can come to the teacher and receive the book. How can the book reach the last boy without being sent through the other boys or by the boy himself receiving the book directly from the teacher? The teacher can throw the book towards the boy and the boy will get the book.

Similarly the heat that can not be transmitted either by conduction or by convection is transmitted by radiation.

Go and sit near the oven in the kitchen. How do you feel? Is there any medium between you and the oven to transfer heat?

The method of transmission of heat without the help of a material medium is known as radiation of heat?

Heat spreads slowly by conduction and convection. But the heat spreads very rapidly by radiation.

The heat that is obtained from the sun is an example for radiation.

The space between the sun and the earth is mostly vacuum. In spite of the absence of a medium in between the earth and the sun, we receive the heat energy from the sun.

When the heat is transmitted by means of radiation, it passes through air or even through vacuum and it is not heated much. But only the object which obtains the heat energy gets heated.

Methods of Radiation

White objects do not absorb a large amount of heat energy by radiation. Conversely, black objects absorb more heat energy. What is the reason?

White objects reflect the heat energy that falls on them. The black object do not reflect the heat energy.

Similarly all the objects which obtain the heat energy by radiation emit some amount of heat energy.

Objects which receive more heat energy radiate it more. Objects which absorb less heat energy radiate little.

Thus we understand the method of transfer of heat energy by radiation from the following experiment.

Experiment

Two rectangular lead plates of the same area are taken. They are fixed in two stands separately

facing each other and leaving some space between them.

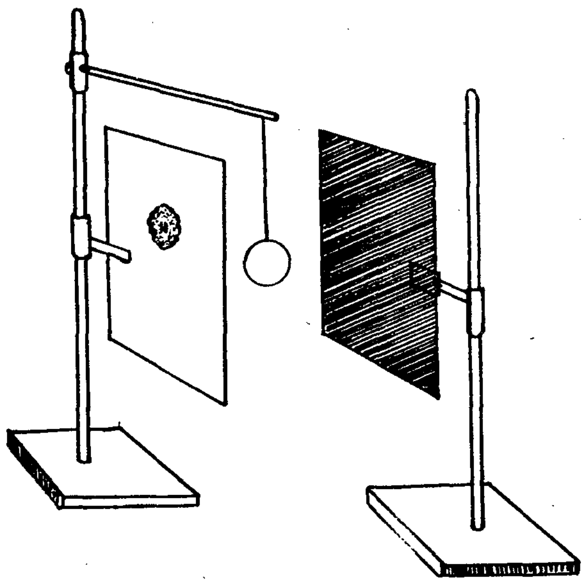


Fig. 81. Heat Radiation

A silver paper is pasted on one plate and this is placed opposite the other plate which is painted black. Two ten paise coins are fixed with the help of wax on the backside of the two plates. The plates are separated by a distance.

A hot iron bob is suspended in the middle between the two plates.

After some time see what happens.

The wax on the back of the black painted plate melts and the coin falls down. After some

time the coin on the back of the white plate also falls.

What is the reason for this? There is no medium in between the iron bob and plates. So, heat cannot be conducted. There is no possibility for heat transmission by convection also. The heat must have been transmitted by radiation only. The black painted plate absorbs heat quickly and so the wax melts and the coin falls down. The shining white plate absorbs less heat energy. So the wax on its backside takes more time to melt.

What do we understand from this experiment?

Black bodies absorb more heat quickly. But they lose more heat by radiation also. But the white bodies or their surfaces absorb less heat and also lose less heat.

The reason for wearing white shirts in summer, keeping hot substances in shining vessels is to prevent loss of heat by radiation.

Thermos Flask

Thermos flask is a good example in which heat is neither lost nor gained by conduction, convection and radiation. Heat is not lost and the cold substances do not get the heat from outside, and are in the same state in the Thermos flask.

It is also known as the Dewar's flask.

Thermos flask is a device used to maintain the temperature of the hot liquid or cold liquid (or) ice at the same temperature for many hours. How?

The thermos flask is a double walled glass vessel. The inside of the walls are silvered. The air between the two walls is evacuated.

There is a sharp end at the bottom of the vessel through which the air was removed and sealed. The flask is kept on a cork and its mouth is closed by another cork lid which is a bad conductor of heat. This flask is kept inside a metal vessel.

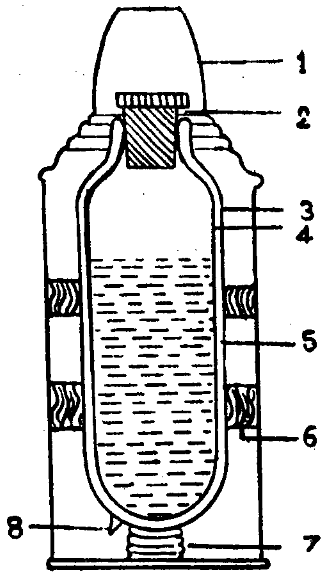


Fig. 82.
Thermos Flask

1. Lid
2. Cork
3. Outside wall
4. Inside wall
5. Vacuum
6. Cork
7. Spring
8. Vacuum seal

How does this flask prevent the loss of heat and absorption of heat from outside?

As there is vacuum in between the two walls, heat is not transmitted by conduction or convection. The glass is a bad conductor of heat. The cork which is used to close the flask is also a bad conductor of heat. Hence loss of heat or absorption of heat cannot take place by conduction. Since the inner walls are silvered, loss of heat by radiation is also prevented.

Thus the heat inside the thermos flask is preserved and prevented from passing out. The heat outside the flask is also prevented from entering the flask.

QUESTIONS

(A) Fill up the blanks in the following:

1. There is no need for a ——————— to transmit the heat by the method of radiation.
2. We get the heat energy from the sun by the method of ———————.
3. By the method of radiation, the ————, ——————— bodies do not get more heat energy.
4. The bodies which obtain less ———— ————, radiate ———————.
5. The thermos flask is also known ———— ———————.

(B) Answer the following questions in one or two words:

1. Name the device in which heat is prevented from being lost by conduction, convection and radiation.
2. What is there in between the two walls of a thermos flask?

(C) Answer the following questions in one or two sentences:

1. What is radiation?

2. How does radiation take place in various substances?
3. It is better to wear white shirts during summer. Why?
4. Hot substances should be kept in the shining vessels. Why?

(D) **Answer the following:**

1. Compare the transmission of heat in substances by radiation by an experiment.
2. Draw the diagram of a thermos flask and describe its construction.
3. How is the temperature of the substance inside a thermos flask maintained?

Exercise

Take two empty tins. Paint the outside of one tin with black paint and on the other paint it with white. Fill them with water and close them. Keep them in the hot sun. After some time observe in which tin the water is warm. Why?

IV. LIGHT

19. RECTILINEAR PROPOGATION OF LIGHT

What is Light?

How do we see things around us? Through our eyes. During the night, can you see the same things?

Light is essential to see things around us.

Light gives life to this world. It is a form of energy. It spreads on all sides in the form of rays.

We can see the object from which the ray starts and falls on our eyes. We are not able to see an object in a dark room.

Luminous objects

From where do we get light?

Maximum light energy is obtained naturally from the sun.

The sun and the stars give us light by themselves. Hence they are called **luminous bodies.**

The moon and the planets in the sky do not emit light of their own. Light from the luminous bodies falls on these, gets scattered and reaches us. Thus we are able to see them.

Thus the objects like wood, wall, moon and stone which are not able to give their own light are known as **non luminous bodies.**

The body through which light can pass is known as **transparent object**. Air, glass and water are some examples of transparent objects.

The bodies through which light cannot pass are known as **opaque objects**. Wall, wood, stone etc. are examples of opaque objects.

Only a certain amount of light can pass through some bodies and they are known as **transluscent bodies**. Ground glass and butter paper are examples for this.

Propogation of Light

How does the light energy travel?

Light travels in straight lines. Its velocity is 3×10^8 metres / second.

Rectilinear Propogation of Light

Experiment

We can prove the rectilinear propogation of light by the following experiment:

Three equal rectangular cardboard screens are taken. Holes are made in each of them at the same height at the centre. The screens are now kept one behind the other leaving some space between each of them. All the three holes should be kept in the same straight line. A candle is lit and put behind one screen. It can be viewed through the hole of the

screen at the other end. The flame of the candle will be quite visible. If the second screen is slightly

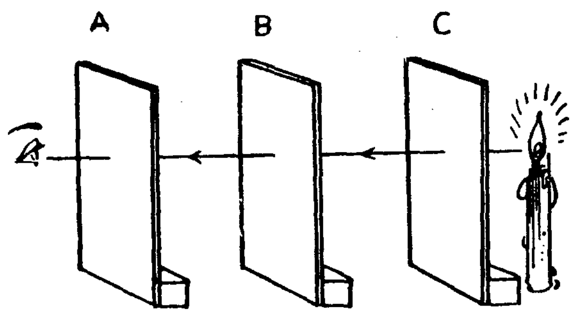


Fig. 83. Rectilinear propogation of light
A, B, C—Three Screens

moved, the flame is not seen. What is the reason for this? The three holes are not in a straight line.

By this experiment it is understood that the rays of light travel in straight lines.

In cinema theatres, we can see the beam of light passing in straight lines from the projector on to the screen.

If there is a hole in the roof of the house, the light passes through it and it is quite visible. If there is smoke or dust in the house the same light will be very well visible as a shaft or a beam of light. The formation of shadow of any object is because of rectilinear propagation of light.

Pin hole Camera

We can prove that light travels in straight lines by using a pin hole camera.

A box made of cardboard is taken. In the front side of the box a small hole is made at the centre by using a pin. The cardboard at the back side is removed and instead a thin ground glass or butter paper is fixed. If any object is placed in front of the pin hole of the box, the image of the object appears upside down on the ground glass. What is the reason for this?

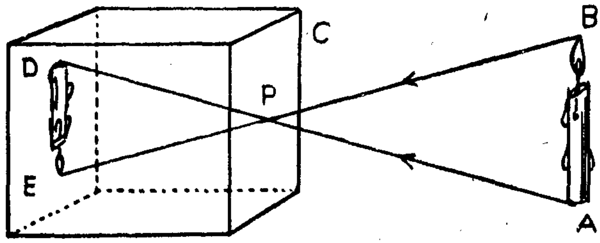


Fig. 84. Pinhole Camera

AB—Object P—Pinhole
C—Opaque box DE—Inverted Image

Since the light travels in straight lines, the rays of light from the top portion of the object pass through the hole and fall on the lower portion of the screen. Similarly the rays of light from the bottom pass through the hole and fall straight on the top portion of the screen and so the image appears upside down.

QUESTIONS

(A) Fill up the blanks in the following:

1. The reason for seeing the objects around us by our eyes is ——————————— energy.

2. Light travels in ——————.

3. The reason for obtaining an image in a pin hole camera is the —————— of light.

(B) **Answer the following questions in one or two words:**

1. From which do we get the maximum light energy naturally?

2. Give examples for luminous bodies.

3. Give examples for non-luminous bodies.

4. Give examples for transparent and opaque media.

5. Give examples for transuluscent bodies.

(C) **Answer the following questions in one or two sentences:**

1. What is light?

2. Mention the different types of light sources.

3. What is a luminous object?

4. What is known as non-luminous object?

5. What is a transparent medium?

6. What is an opaquc medium?

7. What is a transluscent body?

(D) Answer the following:

1. Describe an experiment to demonstrate that light travels in straight lines.

2. Draw a diagram and explain the working of the pinhole camera.

Exercise

Construct a pin hole camera.

V. MAGNETISM

20. MAGNETS

Natural Magnets

Energy is of various kinds e.g. heat energy, mechanical energy, light energy and electrical energy. The attraction of the bodies like iron is an invisible force and it is known as magnetic energy.

The loadstone is an iron ore available in nature and has the property to attract substances like iron, steel etc.

Stones of this type were discovered in Magnesia in Asia Minor and therefore they are called "Magnets". This ore is known as magnetite which is a compound of iron and oxygen. This kind of ore is dug out from the earth in Magnesia, Sweden and the island of Elba.

If this ore is placed on some iron filings and taken out, the iron filings will stick in large quantity to its ends. This kind of stone is found in nature and so it is known as a natural magnet.

When the load stone is tied to a thin string and freely supended so as to rotate in a horizontal plane, it will finally remain pointing towards north and south directions after turning round for some time. So

it was called the leading or the load stone. The magnetic stone was first used as the load stone by the Chinese.

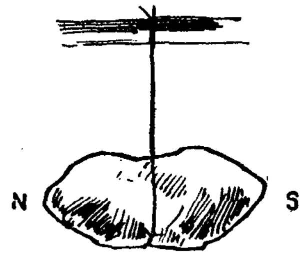
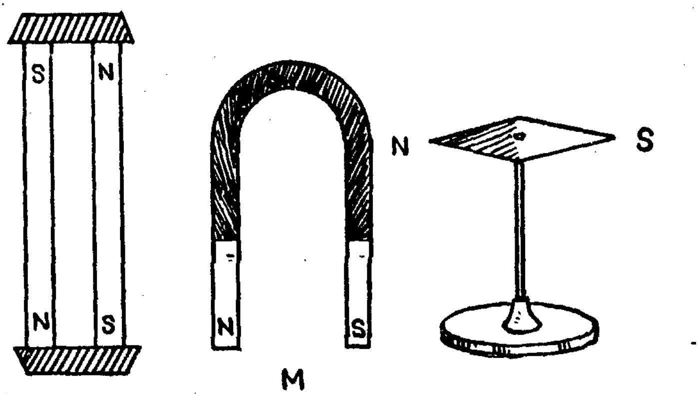


Fig. 85.
Load stone

These magnets are of irregular shapes. They have less energy. They share their energies with substances like iron.

Artificial Magnets

If substances like iron are touched by a natural magnet, they attain magnetic energy. This type of



(a) (b) (c)

(a) Bar magnet (b) Horse-shoce magnet (c) Magnetic needle
Fig. 86. Artificial Magnets

magnet is called 'artificial magnet'. The method of changing some substances into magnets artificially is known as magnetisation.

Artificial magnets have strong magnetic properties. They are manufactured in different forms according to the nature of use for which they are required. Bar magnets, horse-shoe magnets, magnetic needles, cylindrical magnets are some of them.

Properties of Magnets

1. **Magnet attracts magnetic materials like iron.**

Experiment

A piece of steel, soft iron, pieces of nickel, cobalt, a piece of wood, lead and a glass piece are kept in that order on a table.

They are touched one after the other by a natural or an artificial magnet. The magnet attracts the metal pieces like iron, soft iron, nickel, cobalt etc.,. The other materials on the table are not attracted by the magnet. What do we learn from this? The magnet attracts only the magnetic materials.

2. **The magnetic force is concentrated at the poles of the magnet.**

Experiment

A bar magnet is rolled on iron filings. After removing it what do you see? The iron filings will not stick equally on all sides of the magnet. They stick in large quantities at its ends. At the centre we see either a little or no iron filings. What is the reason for this? A large amount of the magnetic force is felt at the ends. These ends are known as the magnetic poles.

3. A pivoted magnetic needle or the suspended magnet tied to a thread shows the north-south direction when it comes to rest.

Experiment

A bar magnet is suspended from a wooden stand by tying it to a thin tensionless string at its centre. The magnet rotates and it comes to rest. Then it points in the north-south direction. So it is known that the magnet has a property to show the north-south direction.

The end of the magnet which points towards the *north direction* is called the *north* pole and the other end which points towards the south is called the south pole.

4. There is a magnetic field around the magnet.

Experiment

A pivoted magnetic needle is placed on the table. How does it show the position when it comes to rest? It shows the north-south direction.

A piece of wood is brought near the magnet at various points around it. Is there any change? Now a bar magnet is brought near the magnet as before. What happens while you do it like that? The magnetic needle rotates. When the bar magnet is removed, it sets itself along the north-south direction.

What do you understand from this?

There is a magnetic field around the bar magnet. The magnetic needle or any other magnetic substance placed in this field is affected.

5. Law of Magnetic Poles: "Like poles repel each other; unlike poles attract each other."

Experiment

A pivoted magnetic needle is kept on the table. The north pole of a bar magnet is brought very near the north pole of the needle. What will happen? The

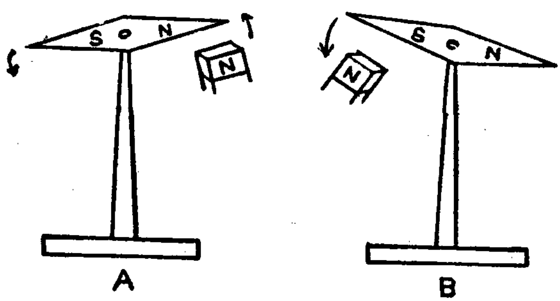


Fig. 87. Law of Magnetic poles

north pole of the magnetic needle is repelled. Then the south pole of the bar magnet is brought near the north pole of the needle, it is observed that the two poles attract each other.

The same experiment is repeated at the south pole of the magnetic needle bringing the north and south poles of the bar magnet near and observe what happens.

If one pole of a magnet is brought near the same pole of another magnet they repel each other. Ins-

tead, if the opposite pole is brought near they attract each other. This is the law of magnetic poles.

So, we understand that like poles repel each other and unlike poles attract each other.

6. **If a magnet is broken into many pieces, each piece becomes a magnet. Each piece will have a North pole and a South pole.**

How to know Magnet

How do we find out whether a substance is a magnet or not?

We can find it by doing some experiments on the magnetic properties.

For example, the substance is supended by a thread and it is left to rotate. When it comes to rest it shows the North-South direction. If it does not show that direction then we can understand that it is not a magnet.

To know it positively and clearly, we can do the experiment based on the law of the magnetic poles.

The north pole of a magnet is brought near any one of the ends of the substance. Even if the substance is attracted by the magnet we can not at once say that it is a magnet. Why?

Now let the south pole of the magnet be brought near the same substance. If it repels, then we can positively say that it is a magnet. If the north pole

repels one end of the substance, then we can say that the substance is a magnet.

The substance obeys the law of the magnetic poles.

Permeability of Magenetic Energy

A bar magnet is kept under a thin glass plate. Iron filings are sprinkled on the glass plate. What do you observe?

How do the iron filings arrange themselves on the glass plate.

They cluster themselves regularly around the magnet with bar magnet at its centre.

The glass plate is removed and other materials like a thin wooden board, paper etc. are placed one by one on the bar magnet and the above experiment is repeated. Again the iron filings arrange themselves in the same way.

What do we understand from this?

It is clear that the magnetic force permeates through non-magnetic substances like glass and wood.

Generally, substances do not have the power to distrub the magnetic effect of a magnet unless they themselves are magnets.

Removal of the Magentic Property

1. If a magnet is struck with a hammer it loses its magnetic power or we say that it is demagnetised.

2. If the magnet is dropped several times it is demagnetised.
3. If the magnet is heated it loses its magnetic power.

Preserving a Magnet

If the poles of a magnet are not protected, the magnet will lose its magnetic property gradually.

What should be done to preserve its property?

The North and South poles of two bar magnets are kept side by side with a wooden piece in between them and two small soft iron pieces are kept at the ends.

The soft iron pieces which are used to preserve the magnetic energy are known as magnetic keepers.

Uses of Magnets

1. The bar magnet, the horse-shoe magnet and the magnetic needle are used in the laboratory.
2. It is used in certain electrical devices.
3. The magnet is also used in dynamos for generating electrical energy.
4. The magnetic needle is used in the Mariner's compass.

The Mariner's Compass

We have already seen that the magnet has the property of showing the direction of North and South.

Many centuries ago, the Chinese and the Romans made use of this property and used the loadstone for finding the direction. They used these stones in their ships.

The Mariner's compass is nowdays used in the ships.

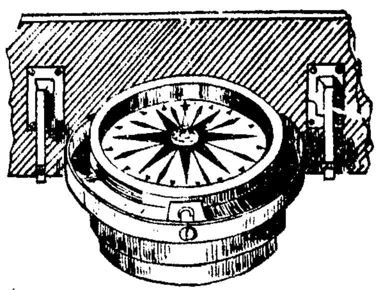


Fig. 88.
The Mariner's Compass

In this instrument, there is a thin, circular mica or aluminium disc on which 32 directions are marked. A magnetic needle is fixed at the centre. The centre of the disc is supported by a vertical spike, which makes a pivotal arrangement. The whole arrangement is kept in a cuplike vessel.

The vessel is fixed through two axes with a metal bracket around. The bracket is fixed at one corner of a wooden box through two axes which are perpendicular to the axes of the vessel. This arrangement is known as **gimbal arrangement.** Even when the ship swings, the plane of the mica disc will always be horizontal because of this arrangement.

There is an index near the rim of the plate. By keeping the length of the index parallel to the length of the ship, the compass is fixed in the ship so that we can find the direction in which the ship is moving, using this index.

To turn the ship in a particular direction, the mariner will so turn the ship that the reference index is aligned with the angle in which the ship has to move and so the ship can proceed safely in that direction.

QUESTIONS

(A) Fill up the blanks in the following:

1. The substances which are attracted by the magnet are known as ________________.
2. The load stone was first used by the ________________ for finding the direction.
3. The two ends of the magnet where the magnetic energy is concentrated are known as ________________ of the magnet.
4. There is a ________________ around the magnet.
5. To protect the magnetic energy ________________ are used as the magnetic keepers.

(B) Answer the following in one or two sentences:

1. What are the two kinds of magnet?
2. Where was the natural magnet found earlier?
3. In what shapes are the artificial magnets prepared?
4. Give some examples for magnetic substances.

5. Give some examples of the substances through which the magnetic force permeates.

(C) **Answer the following questions in one or two sentences:**

1. What is a loadstone?
2. Why is the magnet so called?
3. What is meant by artificial magnet?
4. State the law of the magnetic poles.
5. When do you say whether a substance is a magnet or not?
6. How are the magnetic properties removed from a magnet?
7. The poles of a magnet cannot be separated. Explain.
8. What are the uses of magnets?
9. What is gimbal arrangement? What is its advantage?

(D) **Answer the following:**

1. How do you prove the law of magnetic poles by an experiment?
2. State the properties of a magnet.
3. Describe the mariner's compass.
4. How is the mariner's compass used by the mariners to know the direction in which ship is moving and to swing the ship in a given direction?

Exercise

Take a small rectangular wooden board. Place a bar magnet at its centre. Make four holes out of which two must be on each side and two holes at its two ends. Fix six wooden sticks at the holes after removing the magnet. Now place the magnet in the midst of six sticks. The sticks prevent the magnets from turning any side if it is made to do so. Then place another bar magnet in opposite direction. Now observe what happens.

Part II CHEMISTRY

1. CHEMISTRY AND OTHER BRANCHES OF SCIENCE

Life on earth is possible because of suitable temperature, oxygenated air, fertile soil, favourable to all living beings. The plants and animals form the natural environment. The sun, the moon and the stars in the sky give us light during day and night. Sometimes the weather conditions change and storms occur due to change in atmospheric pressure. Science is the subject which deals with the knowledge of such physical phenomena and things existing in natural environment. Hence knowledge of physical and natural environment is classified into different branches. The following are some of the important branches:

Mathematics, Physics, Chemistry, Biology, Geology and Space science.

Chemistry

Chemistry is an important branch of science. It is knowledge about the composition of matter. It also explains the changes that takes place in substances due to heat, cold and pressure. For example with the help of chemistry one can find out what happens when charcoal burns in air, when iron rusts and when salt dissolves in water. Various chemical methods are used in the making of glass, plastics, paper, nylon, terylene, etc. which are used in life.

Chemistry is closely connected with the other branches of science. The principles and inferences of the other branches of science and discoveries based on them help chemistry to a very great extent. In the same manner, the discoveries, concepts and principles in chemistry are also helpful for the other branches of science. Now let us consider the relationship between chemistry and the other branches of science.

Chemistry and Mathematics

Mathematics is used to a great extent in the development of chemistry. Mathematics helps us to understand the properties of the atoms, their weight etc. Mathematics is also needed to calculate the weight of elements required to prepare new chemical substances and the volume, weight etc. of the by-products.

Chemistry and Physics

Physical concepts are used to a large extent in chemistry. Physics helps us to find out the structure of the atom and its properties. Physical concepts help to explain chemical changes like electrolysis. A knowledge of physics also explains the molecules and their movements in gases.

Chemistry and Biology

Several biological functions are chemical changes. For example, photosynthesis, by which process plants prepare starch by using water and carbon dioxide with the help of sunlight, is a chemical process. This process is necessary for living beings. Chemistry helps to explain the structure of cells,

their action and the function of nucleic acid (D.N.A) as the basic structure of heredity.

Chemistry and Geology

Geology deals with our earth. This branch of science helps to identify different ores in the earth and to separate them. Chemistry helps to a great extent in this work.

Chemistry and Space Science



Fig. 89. Man on the moon

In the history of mankind, space experiments have produced wonderful results. For example we can mention the landing of man on the moon.

Chemistry helps us in the making of materials required for the rockets that are used in space travel. Further, hydrozine, liquid hydrogen, liquid oxygen which are fuels for the rockets are chemical products. When these fuels burn, a good amount of heat is evolved. So rockets are able to move fast.

Exercise

1. Collect the different kinds of soil, stone, wood etc. found in the surroundings of your school. Classify them and keep them in the laboratory.

2. Gather pictures on space travel and make an album.

3. Prepare a big chart showing the different branches of science and their uses.

QUESTIONS

1. What does science deal with?
2. What are the important branches of Science?
3. What does chemistry deal with?
4. How does mathematics help chemistry?
5. What is the relationship between chemistry and physics?

6. Give an example to show that several biological functions are chemical reactions.
7. What does geology deal with?
8. How do discoveries in chemistry help space travel?

For Thought

1. How is the branch of biology classified further at present?
2. Why do space travellers carry oxygen cylinders with them?

2. SCIENTIFIC METHOD

Nature has many resources. These resources can be used to make our lives useful. Scientific knowledge and methods are necessary for us to use these resources.

What is scientific method?

The progress in the field of chemistry is mostly based on experiments. With the help of repeated experiments, scientists are able to discover new truths and explanations.

Experiments should be done by following scientific method. According to this, every matter should be first observed. The regularities found in this, should be selected and new principles discovered

These must be shared with others and scientific knowledge should be enriched.

Therefore scientific method consists of doing experiments, to know the findings, and from the truths found out and with the help of principle (hypothesis) get an explanation.

Experiment 2.1 Burning of Candle

Light a small candle, observe it closely. Note down the changes that occur when the candle burns.

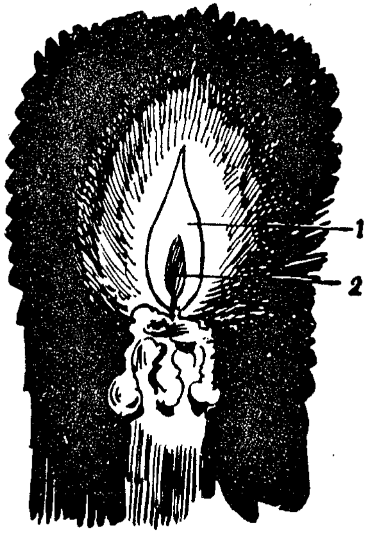


Fig. 90. Burning of a Candle
1. The yellow zone
2. The dark zone

The following are observed when a candle burns:

1. Light is given out from the flame.
2. The outer zone of the flame is yellow in colour and the inner is slightly dark.
3. The wax melts on the sides which immediately becomes solid.
4. The length of the candle is reduced.
5. The flame bends in the direction of the wind.

Experiment 2 2. The properties of certain substances.

Place on the table a little quantity of the following in different containers: common salt, sugar, sand, charcoal, iron filings, water, kerosene, cocoanut oil and honey.

Then go near them and observe closely. Find out the different properties like the state, colour, smell, solubility in water of each of them and tabulate as in table 2—1:

Table 2-1 Properties of substances

No.	Name	State	Colour	Smell	Solubility in water	other properties
1.	Common Salt	solid	white	nil	dissolves	Saltish
2.	Sugar					
3.	Sand					
4.	Iron					
5.	Charcoal					
6.	....					
7.	....					

Experiment 2.3. Properties of charcoal

Hold a piece of charcoal by a pair of tongs and heat it over a spirit lamp. Observe the changes.

Allow the gas that comes out from the burning charcoal through a test tube containing lime water. Shake the test tube and observe the change in lime water.

The charcoal burns with red glow when heated. Even when it stops burning, the smoulder continues to glow for sometime. The gas coming out while burning is carbon dioxide as it turns the lime water milky.

Experiment 2.4. Dissolving of salt in water

Take a 100 ml. beaker, half filled with water. Put powdered salt little by little in the water and stir well with a glass rod. See what happens.

The salt that was put at first dissolves in water. The salt added later also dissolves. But after the addition of a certain quantity of salt if more salt is added, it does not dissolve, but settles down at the bottom of the beaker. What is the inference from this?

1. Salt dissolves in water.
2. A certain quantity of salt dissolves in certain quantity of water.
3. If salt is added more than this quantity, it does not dissolve.

From the facts found out from the above experiment, the following conclusion is arrived at:

In a certain quantity of water only a particular quantity of salt will dissolve. This is known as solubility of that salt.

The above four experiments have explained the scientific method well. The scientific method consists of the following five steps:

1. Close observation.
2. Compiling of truths (gathering information)
3. Forming hypothesis (conclusion)
4. Verifying the hypothesis with the help of experiments.
5. Framing a law, making a general statement with the results thus verified.

Exercise

1. Observe the flame of a kerosene lamp and draw its diagram. Find out if this is the same as or different from a candle flame.
2. Strike a match stick and observe the changes while it is burning. Find out if any new substance is formed when it is burnt.

QUESTIONS

1. Define scientific method.
2. State the five steps of scientific method.
3. What changes do you find when a charcoal burns?
4. Mention four substances that dissolve in water.
5. Describe an experiment to show the properties of charcoal.

6. State the principle of solubility of salt in two sentences.

For Thought

1. Do you know how an hour candle is made use of to denote the time?
2. Why does not salt dissolve in kerosene?

3. KINDS OF FOOD

Our body can be compared to a motor car. The motor car gets energy from the mixture of petrol and air. Similarly our body makes use of the energy derived from the food we eat. The digestive organs of our system, by chemical process convert the food into simpler substances so that cells of the body tissues get energy and heat for all activities. So chemistry gives us the knowledge about nutrient substances in the food we eat. It also helps us to understand which nutrient substances are found in different food stuffs.

The nutrient substances can be classified mainly into three kinds: substances which give energy, substances which help bodily growth and substances which protect our body from diseases.

Carbohydrates, proteins and fats are necessary for life. Proteins and mineral salts are essential for the growth of the body. Besides these minerals, vitamins are also necessary. Some of these are found in very small quantity. It is difficult to separate

them. These are necessary for protecting the body from diseases.

Carbohydrates

Carbodydrates supply us with energy, necessary for us to work. So we call them as energy foods. Carbohydrates contain three elements, carbon, hydrogen and oxygen. The food stuffs rich in carbohydrates are rice, wheat, root tubers like potatoes and sugar.

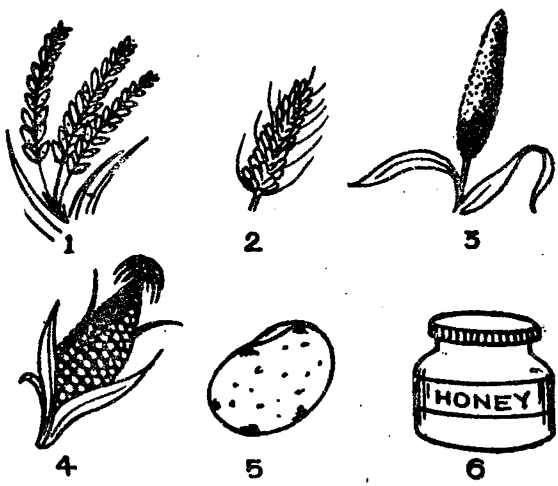


Fig. 91. Foodstuffs rich in Carbohydrates

1.	Paddy	2.	Wheat	3.	Cambu
4.	Maize	5.	Potato	6.	Honey

Sugar used as food are of two kinds. They are (i) Sucrose, the sugar got from cane sugar, and (ii) glucose, the sugar got from fruits.

Sucrose is prepared from the juice of sugarcane. We use this largely in our food. Glucose is found

in fruits like apple, orange, pineapple, grapes, plantain and lemon.

Another carbohydrate which functions like sugar is starch. This is stored by plants in seeds and root tubers.

Experiment 3.1. To identify Starch

Take a little cooked rice in a test tube and add a few drops of water. Then add three or four drops of iodine. See what happens.

Later, instead of cooked rice, take potato chips and bread separately and repeat the experiment. In this experiment dark blue colour will be seen in the test tubes. This shows the presence of starch. In this way iodine is useful to find out the presence of starch in a substance.

Proteins

We grow in size everyday and when we grow, our muscles develop. The substances that help our growth are called proteins. Besides muscles, nerves, glands, blood are made of proteins. Proteins contain the four elements: carbon, hydrogen, oxygen and nitrogen.

Proteins are found in large quantities in milk, pulses, egg, fish, meat of fowls etc. Since these kinds of food are necessary for growth, they may be called tissue foods.

Fats

Another substance, in our food, that gives energy is fat. There are different kinds in this:

animal fats, vegetable fats etc. They are found in substances like meat, vegetable oils and butter.

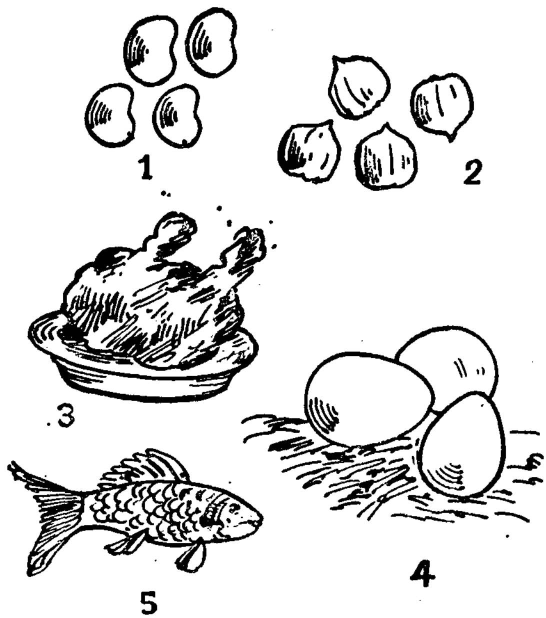


Fig. 92. Foodstuffs rich in protein

1. Beans 2. Bengal gram

3. Mutton 4. Egg 5. Fish

For example, a fat known as stearin is found in mutton. Fats known as Glein and Butyrin are found in vegetable oil and butter respectively.

Minerals

Minerals are necessary for the growth of the body. Further minerals are necessary for effective

chemical changes to take place in our body. For example calcium is very helpful for the growth of the bones and strengthening of the teeth. Iron plays an

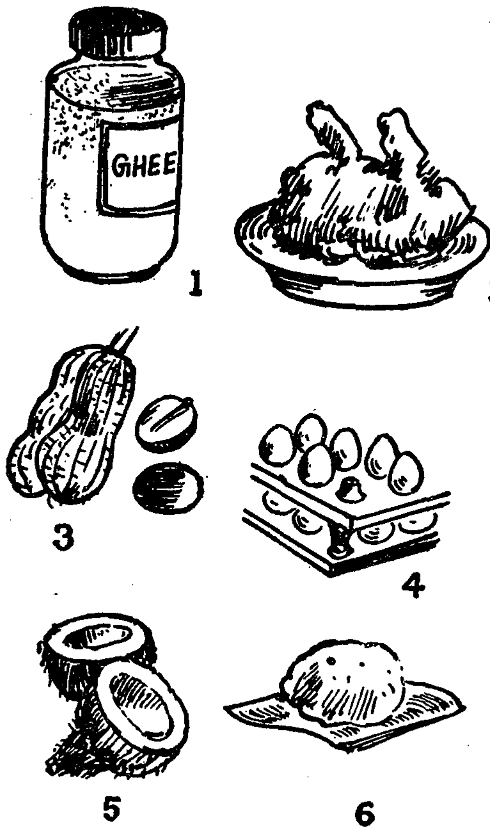


Fig. 93. Food stuff rich in fats

1.	Ghee	2.	Mutton	3.	Groundnuts
4.	Eggs	5.	Cocoanut	6.	Butter

important part in the formation of haemoglobin in our blood. Common salt not only gives taste to

our food but controls blood pressure. Raw vegetables, greens, milk, buttermilk, egg, fish and fruits contain minerals in notable quantities.

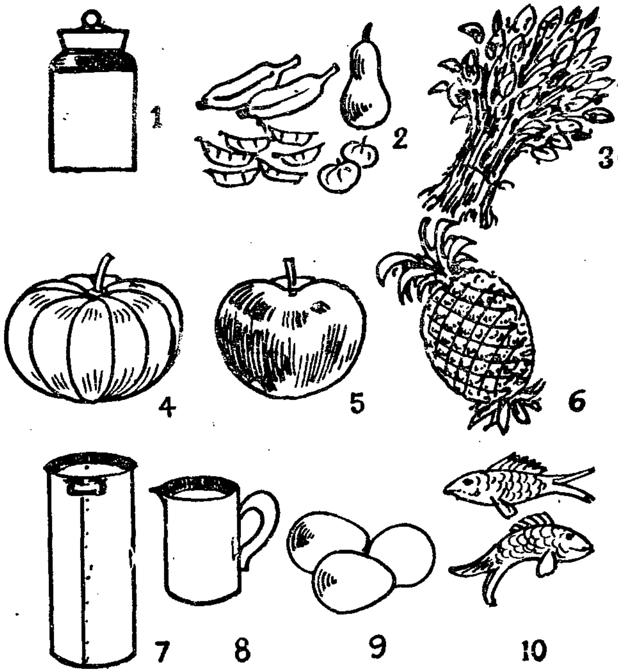


Fig. 94. Foodstuffs rich in minerals

1. Common salt 2. Raw vegetables 3. Greens 4. Pumpkin 5. Apple 6. Pine apple 7. Milk 8. Butter milk 9. Egg 10. Fish

Vitamins

In addition to carbohydrates, proteins, fats and minerals, some other substances are also necessary for us to live. They are called **Vitamins.** They are named Vitamin A, Vitamin B, Vitamin C, Vitamin

D etc. They are naturally present in some of the food stuffs. Now they are artificially prepared.

Each kind of vitamin should be found in required quantity in our food. If not, the growth of the body will be affected. Health also will be affected and will lead to several diseases.

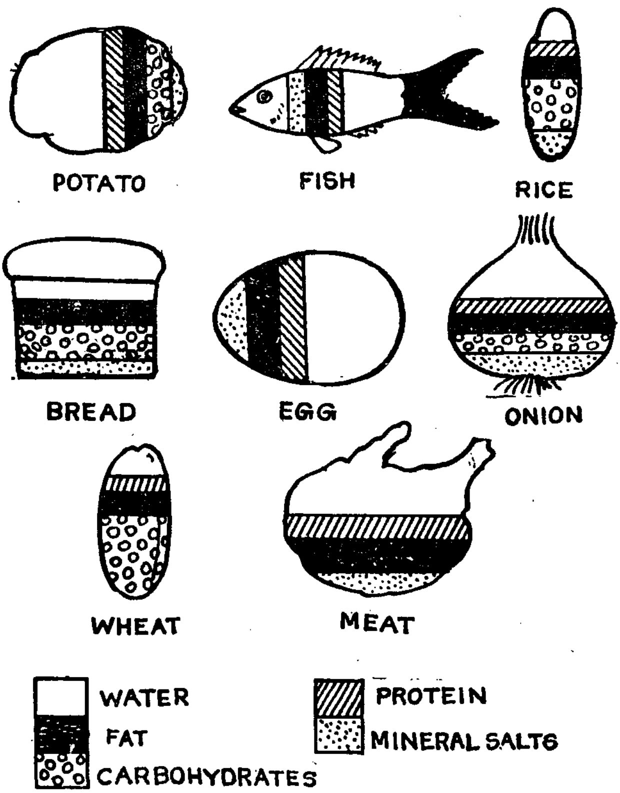


Fig. 95. Certain foodstuffs and their Composition

Vitamin A stimulates growth. This prevents diseases that affect the mucous and tender tissues

found in eyes, nose, throat and lungs. This is found in fish oil, liver, milk, egg, carrot and pumpkin. Its deficiency leads to night blindness.

Vitamin B increases the appetite and helps digestion of the food. This prevents a disease called **beriberi**. Vitamin B is found in foodstuffs, yeast, pork, fish, wheat and cereals.

Vitamin C prevents a disease called **scurvy**. Vitamin C is found in goose berries (Nelli kai), tomotoes, oranges and raw vegetables, lemon etc.

Vitamin D is found in large quantities in fish oils (cod liver oil, shark liver oil). This is found in small quantities in egg and butter also. This vitamin will be produced in the skin when sunlight falls upon it. The deficiency of vitamin D in the food will cause a disease called **rickets**.

Exercise

1. Take a piece of bread in a test tube and heat it over a spirit lamp. Observe that it is giving out heat. What do you learn from this?

2. Classify the nutrient contents of the food stuffs you know according to their major contents as shown in table:

No.	Name	Carbohydrates	Proteins	Fats	Minerals	Vitamin
1.	Rice	√	—	—	—	√
2.	Dhal	—	√	—	—	—
3.	Root tuber	√	—	—	—	—
4.	Raw vegetables	—	—	—	√	√
5.	Fruits	—	—	—	√	√
6.	Vegetable oils	—	—	√	—	—

3. Pluck small leaves in the evening and put them in boiling water and test for the presence of starch.

QUESTIONS

1. How does food help our body?
2. Name the five nutrient substances contained in the food.
3. What are the elements found in carbohydrates?
4. In what food stuffs are carbohydrates found in large quantities?
5. Write two sentences on sucrose and glucose.
6. How will you test for starch in food stuffs?

7. What are the substances required for tissue growth.
8. What are the four elements in proteins?
9. Name the foodstuffs rich in proteins.
10. State two uses of minerals, calcium and iron.
11. Mention four foodstuffs rich in fats.
12. Name four foodstuffs rich in minerals.
13. Choose answers from Part A to match items under Part B and write its number in the bracket.

Part A	Part B
1. To prevent beri beri	a. Vitamin A ( )
2. To prevent scurvy	b. Vitamin B ( )
3. To prevent toothache	c. Vitamin C ( )
4. To prevent night blindness	d. Vitamin D ( )
5. To prevent rickets	

For Thought

1. Do you know the diseases caused by the deficiency of Vitamin E and Vitamin K?
2. We use vegetable oil for burning lamp. What inference do you make from this about the property of fats?

4. FUELS

We use wood, charcoal, leco, kerosene, gas and similar substances for cooking food in our homes. We call these fuels. What are fuels? Substances that burn in air and give out much heat are called fuels.

Fuels can be classified into three kinds: (i) solid fuels (ii) liquid fuels and (iii) gaseous fuels.

1. Solid fuels

Solid fuels that are used to a great extent in homes are firewood and wood charcoal. Some use leco that is prepared from lignite. Coal is very much used as fuel in factories, trains and ships. Wood is made up of a substance known as cellulose.

Wood fuel is used to a large extent in homes for cooking food, since it is available easily and in large quantities and since it produces plenty of heat. Wood charcoal is prepared by burning of wood with a limited supply of air. Wood charcoal is light. This gives more heat than wood fuel.

Coal is an important solid fuel. Millions of years ago, a large number of trees of the forests had been buried under the earth. Heat, pressure and lack of contact with air have changed these plants into coal. This is dug out from the earth. There are several kinds of coal. In Tamilnadu brown coal called lignite is available at Neyveli in South Arcot district. When lignite is heated and compressed,

the fuel leco is got. Leco burns just like coal. Lignite is used for producing electricity.

2. Liquid fuels

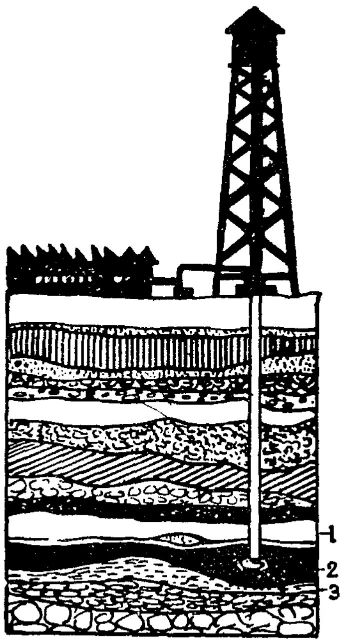


Fig. 96.
Petroleum well

1. Gas 2. Oil 3. Water

Petrol is an example of liquid fuel. It is found in certain places under rock beds. At these places holes are drilled and tubes are inserted and petroleum is brought above the surface of the earth. It is then refined in refineries. When petroleum is thus refined petroleum gas, petroleum ether, petrol, kerosene, diesel oil, paraffin wax and tar are obtained as several products.

Liquid fuels are needed for internal combustion engines and jet engines. Petrol and diesel oil are used as fuel in lorries, buses and cars. Kerosene is used for lighting and in the stoves.

In laboratories, spirit lamp is used for heating substances. Methylated spirit is used for this purpose. This evoporates easily. Much smoke is not given out when spirit burns.

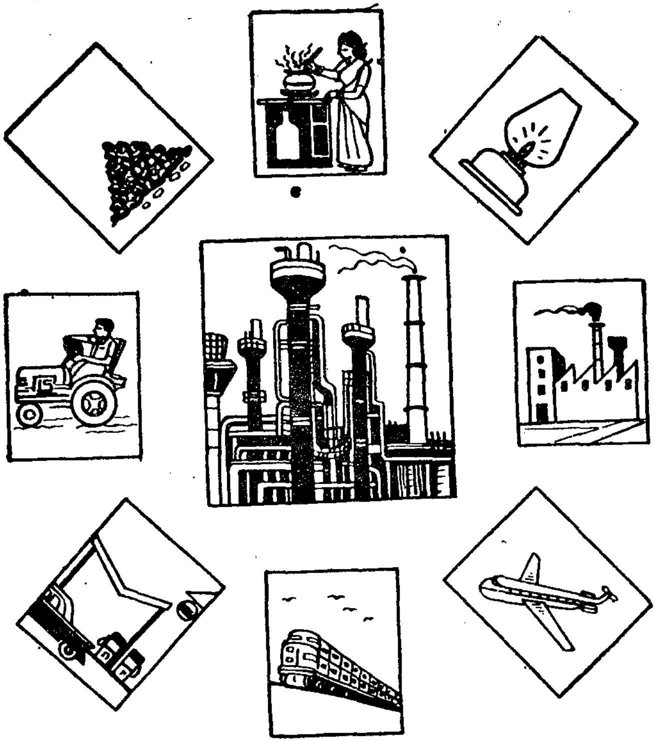


Fig. 97. Petroleum and its products

Experiment 4.1 Spirit lamp and its parts

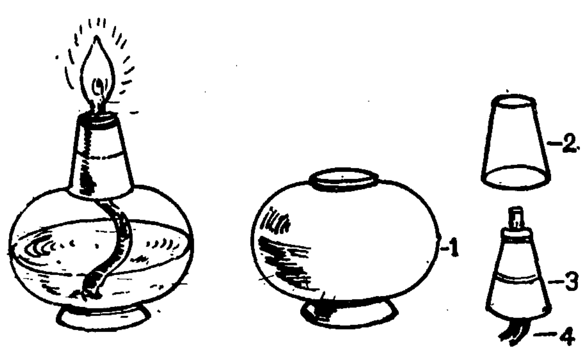


Fig. 98. Parts of a spirit lamp

1. Round flask 2. Neck 3. Lid 4. Wick

Take a spirit lamp and detach it into parts. Find out the use of each part. With the help of a funnel, fill up three fourths of the flask with spirit. Fix the neck to the round flask and wipe with a cloth. (Why?). Now light the wick. A little later, put the lid over the neck and see what happens!

3. Gaseous fuel

Natural gas, coal gas, petroleum gas and water gas are some of the examples of gaseous fuels. In some respects these are better than solid and liquid fuels. We can control the burning using the required quantity. Further these fuels can be easily sent from one place to another through pipes.

Gaseous fuel is stored under high pressure in strong metal cylinders. Indane gas is sent to homes in such a way that is used for burning stoves.

Exercise

1. Collect the easily available fuels like charcoal, leco, petrol, kerosene, diesel oil, spirit and examine their qualities. Put them in bottles and label them.

2. Detach a kerosene stove used in the home and examine its parts. Draw a diagram.

QUESTIONS

1. What is a fuel?
2. What are the kinds of fuels? Give two examples for each kind.
3. How was coal formed? What are its uses?

4. What is the kind of coal that is found in Tamilnadu? Where is it found? State two of its uses.

5. Mention any four products of petroleum and their uses.

6. Choose the most suitable answer out of the four given statements.

Methylated spirit is used in the laboratory because.

(a) it is easily available.

(b) it heats substances very quickly.

(c) it does not give out smoke.

(d) it produces much heat. ( )

7. Give two examples of liquid fules.

8. Draw the diagram of a spirit lamp and name its parts.

9. Explain in two sentences that gaseous fuel is better than solid and liquid fuels.

For Thought

1. How is the petroleum found under the sea near Bombay taken out?

2. What is the fuel used by Eskimos?

5. METALS AND ALLOYS

What are metals?

Utensils and tools we use at home are made of metals. Metals occupy an important place in our

daily life. We use utensils made out of brass, aluminium, lead, silver, stainless steel etc. The wires that conduct electricity to our homes are made of copper or aluminium.

Motors, buses, trains, ships, aeroplanes are useful for going from place to place. In all these there are parts made of metals like iron, aluminium and magnesium. Metals are largely required to make machineries used in factories.



Fig. 99. Ship building yard

Properties of Metals

Pure metals have lustre. This is called metallic lustre. It is because of this property that materials made out of metals are very beautiful. Silver is

white. Gold is yellowish. Copper is reddish brown in colour.

If certain metals are kept open, they lose their lustre. This is because of the wet air. A thin film of oxide or carbonate or sulphide is formed. This film can be removed by rubbing with sand paper.

Most of the metals are solids at the ordinary temperature. Mercury is the only metal which is a liquid at ordinary temperature. Metals are generally heavy. But sodium and potassium are less dense than water.

Metals are generally strong. This quality differs from metal to metal. Sodium can be cut with a pen knife but iron can not be cut easily.

Metals can be struck into thin sheets. This quality is called malleability. Gold can be made into thin sheets of 0·000001 cm. thick. Metals are also ductile. A gram of gold can be made into a thin wire of two kilometres long.

Uses of Metals

Because of the malleability and ductility of metals, they are very much useful. They are made into thin sheets. Utensils of different kinds are made out of these metal sheets.

They are used to keep materials safe and covered. Extremely thin foils of gold and silver are used in making jewels. Aluminium foils are used to cover chocolates, protect medicinal tablets and feeding

bottles etc. Copper and aluminium are good conductors of heat. So these are used in making utensils.

Metallic Corrosion

If certain metals are kept open in air, a thin film covers its surface. The colour fades. We know that articles made of iron become rusty. This kind of action is known as **metallic corrosion.** Because of this, metal is wasted. Every year crores of rupees worth of metal is wasted in this manner.

Metallic corrosion can be prevented by two ways. First the contact between the metal and moist air must be prevented. Paint is coated on the metals for this purpose. Another way is that one metal is melted and coated over another metal. You can understand this from the following examples:

1. Iron sheets used for the roof coverings are coated with melted zinc. We call these iron sheets galvanised iron sheets.

2. Thin iron sheets, used for making boxes or cans are coated with tin.

3. Kitchen utensils made of copper are coated with tin. This is called tinning. By this, the formation of food poison is prevented in these copper utensils.

Alloys

Pure gold is soft. This metal bends very easily. If a little copper or silver is added, it becomes hard. Now it can be converted into strong sheets and wires.

Alloys prepared in this manner are stronger than the pure metals. They are not generally affected

by metallic corrosion. Brass, bronze, solder, type metal, nichrome, stainless steel are some of the alloys.

Exercise

1. Collect materials in the shape of wires, sheets and cylindrical rods of iron, brass, copper, steel and examine them to know their qualities like colour, lustre, strength and malleability.

2. Observe copper utensils being cleaned with sand and also the use of sal ammoniac (Ammonium chloride) before the actual tinning is done.

3. Connect two battery cells with a torch bulb by means of an insulated copper wire and see the bulb glowing.

QUESTIONS

1. Mention four metals that are used in daily life and explain how they are useful.

2. State any four properties of metals.

3. How does metallic corrosion happen? How can it be prevented?

4. Complete the following:
   (i) The metal that is used for conducting electricity is ——————.
   (ii) The metal that is mostly used for covering medicinal tablets is ————.

5. Mention four alloys and explain the use of each.

For Thought

1. What is the carat value of pure gold ?
2. What is the carat value of gold used for making jewels ?

6. AGRICULTURE AND MEDICINE

For erecting factories, big buildings are required. Iron and cement are used in the construction of buildings. Cement is a chemical product. Chemistry, has added much to the progress of industry. The application of chemical knowledge has increased the progress of agriculture. Agriculturists produce more by using various kinds of fertilisers. These fertilisers are chemical products. Today the average life span of people is more than what it was a century ago. Medicines like aspirin, sulpha drugs, penicillin which are produced with the help of chemistry are largely responsible for this.



(A) (B)

Fig. 100.

Fertilisers and growth of crops

A. —Crop for which fertilisers are not used

B. —Crop growth with the help of fertilisers

Chemistry in Agriculture

Manures are necessary for the growth of rich crops. Formerly agriculturists used composed farm manure like cowdung, cattle

waste and natural manure of green leaves etc. But these do not give the necessary amount of nutrients to the fields. Therefore artificial fertilisers like ammonium sulphate, urea, superphosphate have to be used. All these are the products of chemistry. There are factories of Sindri (Bihar), Neyveli, Manali in our country to produce these fertilisers.

Minerals are necessary for the growth of the body. In the same way, three substances, nitrogen, phosphorus and potassium are very essential for the growth of crops. These are respectively called as leaf nutrition, cereal nutrition and cinder nutrition. The uses of these are given below:

1. Nitrogen

Nitrogen is essential for the production of protein in plants. Plants will be green and healthy if this is available in required quantities.

2. Phosphorus

Phosphorus is necessary, for the growth of grains and seeds. Further it helps the roots to grow well.

3. Potassium

Chlorophyll is necessary for the process of photosynthesis. Potassium is necessary for the production of this in plants. Further potassium is necessary for the good growth of plants and to resist plant diseases and pests.

To make the required amount of the three substances nitrogen, phosphorus and potassium available

to the plants, more than one fertiliser is mixed in definite quantities and put in the fields. These are called **mixed fertilisers.** These are also called *N. P. K.* fertilisers. Where *N* stands for nitrogen, *P* for phosphorus and *K* for pctassium.

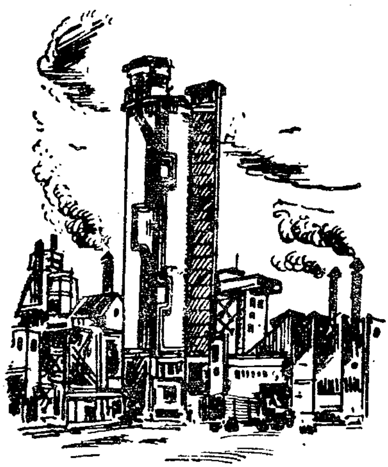


Fig. 101.
Fertiliser Plant

Fertilisers that are used mostly in agriculture are given in the tollowing table. All of them are produced in chemical factories.

Table 6-1 Artificial fertiliser

Nutritive substances	Fertilisers
Nitrogen	Ammonium sulphate Ammonium phosphate Urea.
Phosphorus	Super phosphate Ammonium phosphate
Potassium	Potassium nitrate Potassium chloride

Pesticides

When crops grow, certain insects destroy them. To save the crops, many pesticides are used. These chemicals are sprayed on the affected crops. On account of this, the insects die. The crops grow well.



Fig. 102. Spraying of Pesticides

Gammexane and Bordeaux mixture are two examples for pesticides. Gammexane is prepared from certain organic substances using chlorine gas. Bordeaux mixture is a mixture of copper sulphate, slaked lime and water. They are used to protect crops from insects.

Chemistry in medicine

With the help of chemistry many drugs are produced to treat the diseases that affect mankind. The drugs can be classified into two kinds—drugs that are used to prevent diseases, and drugs that are used to cure the diseases. We use pox vaccines to prevent small pox and B.C.G. to prevent tuberculosis. Nowadays triple antigen is given to children

to protect them from the infection of tetanus, whooping cough and diptheria. By the use of antiseptics the disease causing germs can be killed. Bleaching powder, potassium permanganate and phenol are examples of antiseptics.

We shall see some of the drugs which are helpful to cure the diseases. Aspirin is a medicine which is used in the treatment of headaches, cold, fever. Sulpha drugs are greatly used for treating boils, scabies and wounds. Penicillin is an effective cure for pneumonia, chloromycetin is used for the treatment of typhoid fever. Quinine is used for curing malaria. All these are discoveries of chemistry.

Exercise

1. Collect the available fertilisers, keep them in small bottles and label them.
2. Look in the fields and observe the application of fertilisers and spraying of pesticides.
3. Consult any doctor and get information regarding important medicines and the diseases for which they are generally used.

QUESTIONS

1. Name four artificial fertilisers.
2. What are the uses of nitrogen, phosphorus and potassium to crops?
3. What are mixed fertilisers? How are they prepared.

4. Complete the following:
   (i) The substance known as cinder nutrition is ————————.
   (ii) The substance known as leat nutrition is ————————
   (iii) The substance known as cereal nutrition is ————————.

5. Choose the most suitable answer out of the given answers:

Quinine is the medicine for the treatment of

a — typhoid
b — malaria
c — pneumonia ( )

6. Give two examples of pesticides.

7. Mention the uses of aspirin and penicillin

For Thought

1. The use of D.D.T. as pesticide is not recommended nowadays. Why?

2. Mention a drug which serves as anaesthesia in the field of surgery.

7. COMMON SALT

Salt is an important substance that adds taste to our food. It not only gives taste but also preserves food stuffs. So the proverb goes "Salt is the spice of life". Salt is known as sodium chloride. Salt

is used in other ways also. Chemical substances like washing soda, baking soda, bleaching powder, chlorine are prepared from the common salt.

How do we get common salt? This is got from sea water, salt lakes and salt beds etc.

Many salts are found mixed in the soil and rocks. They dissolve in rain water. Rain water joins the rivers and reaches the sea. In this manner salt reaches the sea. This has been happening for millions of years. On account of this, sea water contains plenty of sodium chloride and other salts. In the same manner certain salt lakes and inland seas have became salty.

Rack Salt

The major portion of the salt that is being used in the world is got from rock salt. These salt layers are found at certain depths beneath the surface of the earth. Rock salt is sodium chloride in crystalline form. This is found in countries like United States of America, Canada, Austria, Russia, Germany, England and China. In India, sodium chloride is found as deposits in some dried lakes of Punjab and Rajasthan.

Preparation of Salt from Sea Water

Beds are prepared to receive sea water. The sea water is taken to the beds and allowed to remain there. The water will evaporate. Salt will be deposited. This salt is gathered in heaps and used for food. The places where salt is prepared in this manner are called **Salterns.**

In Tamilnadu large number of salterns can be found in coastal areas of Ennore, Tuticorin and Adirampattinam. Salt got in these places is sent to different parts of the country.



Fig. 103. Saltern

Sea water contains about 3·3% of dissolved salt. In the "sea salt" which is got by evaporating the sea water, sodium chloride is found in large proportions. Besides this, salts of magnesium, calcium and potassium are also found in it.

Preparation of Rock Salt

Rock salt is found as deposits in certain places of the earth. Mines are dug in these places and salt is got as large blocks and powdered. In certain places the salt deposits are found at great depths beneath the earth's surface. At such places, holes are drilled in the earth. Water is pumped in at high pressure and concentrated saline solution is got.

Preparation of Table Salt

Salt is not pure. Many impurities may be found. We purify and use it as table salt. The method of preparation of the table salt is as follows: The sea salt is dissolved in a little water and the solution thus got is filtered. By this many undissolved impurities are removed. The filtered solution is, evaporated and salt is got. This salt is easily soluble. It is used in large quantities for cooking food.

Properties of Common Salt

Common salt is in the form of white crystals. Its crystals are cubic in shape. If salt is heated, it breaks into bits and turns into powder. If a crystal of common salt is kept in the flame of spirit lamp, yellow colour is seen in the flame. This yellow colour in the flame is a special property of this salt.

Common salt is easily soluble in water. Freezing mixture is a mixture of ice and salt in the proper proportion 3:1. The temperature of this mixture is — 21°*C*. Freezing mixture is used for preparing ice cream.

If common salt is kept open in air, it becomes moist. This is because common salt contains a little calcium chloride and magnesium chloride also. These substances have the property of absorbing moisture from the air.

Uses

Common salt is largely used for preparing food stuffs. Salted pickles etc., do not get spoiled even after a long time.

Common salt is used in the preparation of many chemical substances. The list of substances thus prepared are given below:

1. **Sodium carbonate:** This is known as soda ash or washing soda. This is useful in washing clothes and cleaning materials.
2. **Sodium bicarbonate:** This is known as baking soda. This is used in the preparation of bread, idli etc.

3. **Sodium hydroxide:** This is known as caustic soda. This is used in the preparation of soap.

4. **Bleaching powder:** It is used in keeping the surroundings free from germs. It is also used to purify drinking water.

5. **Hydrochloric acid:** This is largely used in laboratories. Many chlorides are also prepared with the help of hydrochloric acid.

6. **Chlorine:** This is yellowish green gas. This is used in the cities to kill germs in drinking water, to bleach clothes, paper etc.

Exercise

1. Observe a few common salt crystals under a hand lens and find the shape of the crystals.

2. Take a little amount of salt and spread it on a glass plate. Observe the change it undergoes after a day or two.

3. Take two pieces of ice in two separate dishes. Add a pinch of powdered salt to one dish and leave the other dish without adding salt. Of the two observe which melts quickly.

QUESTIONS

1. Explain the reason for the salt content of sea water.
2. How is salt prepared from sea water?

3. How is salt got from rock salt?
4. Describe the method of preparing table salt.
5. Where is rock salt found in India?
6. State four properties of common salt.
7. What is freezing mixture? What is its use?
8. Why does salt kept open in air become wet?
9. Give the names of four chemical substances prepared from common salt. State the uses of each.

For Thought

1. Do you know the use of salt in glazing clay pots and in glass industry?
2. Why do the doctors advise the gorgling of salt water for throat trouble?

8. PHYSICAL AND CHEMICAL CHANGES

We find substances either in one of the three states, solid, liquid or gas. A substance may change from one state to another. For example when water boils, it turns into steam. When steam condenses, we get back water. This is an example for the change of state.

Experiment 8.1

When a bit of sodium chloride salt is heated over a spirit lamp, it breaks into bits. Each one is still a sodium chloride. But when magnesium ribbon

burns in air, a white new substance is formed. We can not get back magnesium easily from it.

So the changes that happen to substances can be divided into: (1) Physical changes and (2) Chemical changes.

During physical change, only physical properties change. For example, when water boils, it changes into vapour and when it is cooled it changes into water drops. When sodium chloride is heated, it breaks into bits and does not form any new substance. There is no change in its property or quality.

Experiment 8.2

When magnesium ribbon burns in air, it combines with oxygen in air and becomes a new substance called magnesium oxide. Further in this change light and heat are given out. This reaction is an example of chemical change.

Physical changes

To know more about physical changes do the following experiments:

Experiment 8.3—Physical Change-I

Observe the colour of nichrome or steel wire. Hold it with tongs and heat it for about three minutes in the flame of a spirit lamp. See what happens. Afterwards remove the wire from the flame and keep it for sometime and observe its appearance once again.

Experiment 8.4 Physical Change-II

Put a piece of ice in a beaker. Observe what happens after sometime.

Take the water got from this experiment in a test tube. Keep this in a freezing mixture for sometime and see what happens.

(*Note*: Freezing mixture should be got by mixing pieces of ice and common salt in the ratio of 3:1.)

Chemical Changes

The following experiments are done to see how chemical changes take place and to know their properties:

Experiment 8.5 Chemical Change-I

Take a little sulphur in a long tea spoon. Heat it well. See what happens.

Experiment 8.6 Chemical Change-II

Take a little lead nitrate solution in a test tube. Add a little potassium iodide solution to it. What happens?

Now heat the test tube and gently cool it. Shake the test tube well and see if any new substance is got.

The results of the above experiments are tabulated below in Table 8.1:

Table 8.1.

No.	Physical change	Chemical change
1.	It is a temporary change.	It is a permanent change.
2.	No new substances appear.	Entirely new substances are obtained.

Conditions needed for Chemical Changes

A match stick will burn. But if it should burn, it should be rubbed against the rough surface on the side of the match box. When the stick is rubbed in this manner, the heat that is produced causes the chemical substances at the top of the stick to burn. So it is clear that heat is usually necessary for the chemical changes to take place. Another example is the burning of magnesium ribbon in air.

In Haber method of preparing ammonia, nitrogen and hydrogen are subjected to a great pressure at high temperature. The gases are then cooled. As a result, liquid ammonia is formed. This is an example to show that chemical change takes place under pressure also.

In the preparation of oxygen, a mixture of potassium chlorate and manganese dioxide is heated. In this mixture, the manganese dioxide acts as catalyst to help the process of letting out oxygen quickly. This is an example to show that chemical change takes place in the presence of a catalyst also.

Chemical changes are varied. The following conditions are necessary for such changes to take place: (1) close contact (2) heat (3) light (4) electricity (5) pressure (6) catalyst.

The Immediate Effects of Chemical Changes

You would have heard the loud sound caused when crackers are burst during Deepavali festival and should have also seen light of different colours when colour sparklers are burnt. The bursting of crackers and the burning of sparklers are chemical changes. So in chemical changes sound and light are observed.

In houses during white washing, water is added to quick lime to make large quantities of slaked lime. Much heat is produced in the chemical change. The water in it boils of its own accord.

The torch light which we carry when we go out during nights, contains battery cells. The chemical substances in them react and produce electricity.

So when chemical changes take place heat, light, sound, change of colour or electricity are produced.

Exercise

1. Take a little ammonium nitrate in a test tube. Heat this and observe the change.

2. Take a little quantity of petrol in a dish and keep it open for sometime. Observe the change.

3. Blow air through a glass pipe into a test tube containing lime water and observe the change taking place in lime water.

QUESTIONS

1. Mention an example for the change of state in substances.
2. Give an example for physical change and chemical change.
3. What are the main differences between physical change and chemical change?
4. State the conditions necessary for chemical change with suitable example for each condition.
5. Mention some of the effects of chemical changes with example for each effect.
6. Classify the following changes into physical and chemical changes:

   (i) Melting of wax (ii) burning of firewood (iii) changing of milk into curd (iv) melting butter into ghee (v) glowing of the filament in a bulb (vi) heating of iodine (vii) burning of camphor.

For Thought

1. Take a few copper turnings in a test tube and add a few drops of sulphuric acid. There is no reaction. Then heat it over a flame. A gas with a strong smell is got. What is the condition under which the chemical change has taken place?

2. The photo film in a camera gets the image of the objects when it is exposed. State the condition that makes the change in the photo film.

9. DIFFERENT TYPES OF CHEMICAL CHANGES

Chemical combination

In this world all substances are not elements. Many of them are compounds formed out of more than two elements. Thus an element combines with another element to form a compound.

In the previous chapter you learnt that the element, sulphur, burning in air, combines with another element, oxygen, to form a new substance called sulphur di oxide. Such a change is called **Chemical combination** or **Synthesis.**

The burning of magnesium in air to form magnesium oxide and the combination of nitrogen and hydrogen to form ammonia are some examples of chemical combination.

Chemical decomposition

In some chemical changes, a substance is split into different substances. This kind of change is called chemical decomposition. We can understand this from an experiment.

Experiment 9.1 Chemical decomposition

Take a little mercury (II) oxide in a dry test tube. Observe its appearance. Slant the test tube

and heat the oxide of mercury (II). What happens? Introduce a red hot splinter into the test tube and see what happens.

In the above experiment, the mercury (II) oxide gives silvery liquid mercury and oxygen due to heat. This reaction is an example of chemical decomposition.

Besides chemical combination and chemical decomposition, there are other kinds of chemical changes also. You will learn about them in the higher classes.

Exercise

1. Take a little sodium carbonate (washing soda). Add a few drops of hydrochloric acid and observe the gas coming out. Introduce a burning candle into the test tube and see what happens. How do you classify this chemical change?

2. Take a little lead nitrate in a test tube. Heat it well. What happens? Introduce a red hot splinter in the test tube and observe the change. How do you classify this chemical change?

3. In every district there are factories producing chemical substances. Try to get information about the chemical products that are produced in the factories of your district.

QUESTIONS

1. Name four elements.
2. Mention two compounds and the elements of which they are made of.

3. State the different types of chemical changes. Give an example for each.

4. What is the chemical substance got when iron rusts? Decribe whether it is a chemical combination or a chemical decomposition.

For Thought

When a little piece of phosphorus is burnt in air, it gives out a white smoky gas. What is the gas? How do you classify this chemical change?

Part III BIOLOGY

FOREWORD

All around us we see so many types of living organisms. When you observe them carefully and study them, you are struck with awe and wonder. Let us reflect over an illustration.

Look at a spider. How does it weave its web? All of us appreciate the skill of the spider in weaving the web. It is so beautiful and the spider seems to have taken great care on every minute detail. It does not make any errors while making its web.

If you observe the above aspects of a spider's web, some questions, such as the following may arise in your mind:

1. Do all spiders make the same type of web?
2. What is the stimulus for the spider to commence weaving a web?
3. Will a spider go and live in a web built and later abandoned by another spider?

You are perhaps aware that till recently the Skylab was revolving around the earth. A child (from the U.S.A.) like you developed a design for 'an investigatory project on the spider's web for the Skylab.

Will a spider be able to weave a web in space (in weightlessness)?

If it does weave a web, will there be a difference from the one that is built on the earth by the same species of the spider?

You are learning biology and you should observe life around you, in the environment. You can first ask *questions on the observed data.* The questions should be such that you cannot obtain answers easily. Plan an investigatory project and carry it out at home or at school. You are sure to get some answers through investigations done by yourself. How thrilling it will be! You will surely succeed. Go ahead with this kind of activity based on investigations.

I. CHARACTERISTICS OF LIVING ORGANISMS

1. KINDS OF ANIMALS

Thousands of animals are living around us. Some are big like the elephant, others small like the ant and yet others like amoeba which could be seen only through the microscope.

Amoeba is made of only one cell, whereas the elephant is made up of millions of cells. You will study in detail about the internal structure of cells in the higher classes.

Though amoeba is made up of only a single cell, it is able to perform all the activities of life. It can feed, move from place to place and reproduce.

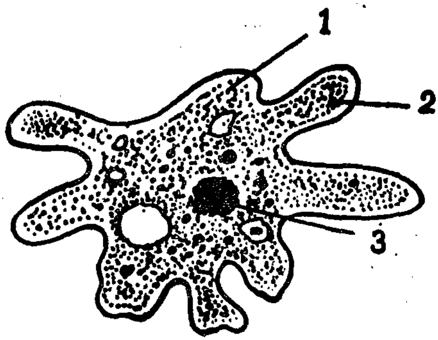


Fig. 104. Amoeba
1. Cytoplasm 2. Pseudopodium 3. Nucleus

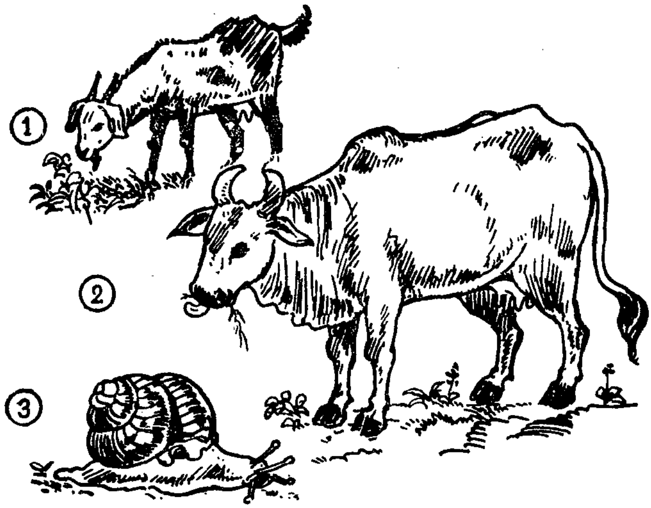
There are a number of micro-organisms like amoeba. Can you find out the names of two other unicellular animals?

We can classify animals as macroscopic and microscopic (on the basis of their size). In addition to this criterian, we can use other criteria to classify the animals, such as the following:

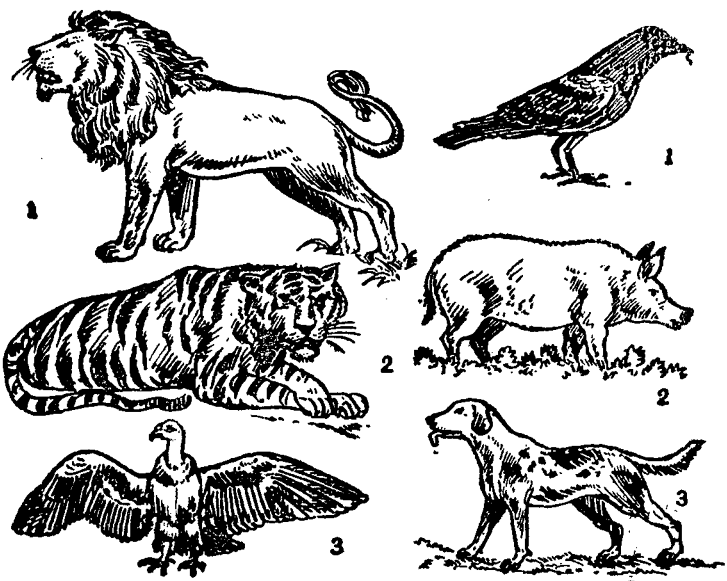
(i) the food they take
(ii) the environment in which they live
(iii) presence or absence of backbone
(iv) maintenance of constant or changing body temperature

Let us first consider the nutrition in animals.

Animals like snail, cow, goat and deer eat plants and they are called **Herbivores.** Those, such



(a) Common Herbivores
1. Goat 2. Cow 3. Snail



(b) Common Carnivores
1. Lion 2. Tiger
3. Eagle

(c) Common Omnivores
1. Crow 2. Pig
3. Dog

Fig. 105.

as lion, tiger and eagle eat other animals. They are called **Carnivores.** Crow, pig and dog eat both plants and animal food. They are called **Omnivores.** You can find out some more examples.

Secondly, we shall classify them according to the environment in which they live.

Try to complete the tabular column given below:

S.No.	Critaria for classifying animals on the basis of the environment they live in	Examples	Special features
1.	In water	1. 2.	1. 2.
2.	In air	1. 2.	1. 2.
3.	Underground	1. 2.	1. 2.
4.	Above the ground	1. 2.	1. 2.

Where do frogs live? They live on land as well as water. How will you classify the frog? What are the special adaptations to live in water and land?

Thirdly animals can be divided into two groups-vertebrates, having backbone, and invertebrates which do not have backbone. Fish, frog, lizards, birds

and mammals are vertebrates. Amoeba, leech, spider, crab and starfish are invertebrates. Can you give some more examples?

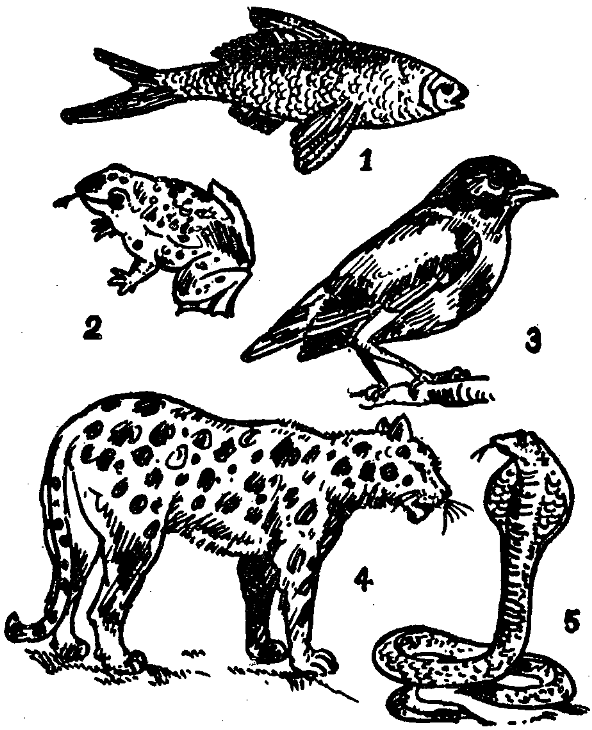


Fig. 106. (a) Vertebrates

1. Fish 2. Frog 3. Sparrow 4. Leopard 5. Snake

Some animals like fish, lizard, snake, frog, tortoise do not have a constant body temperature. Their body temperature gets adjusted to the temperature of the surrounding. These are called **cold blooded animals.** But the body temperature of birds and mammals is not affected by the temperature of the.

surrounding. It remains constant. These are **warm blooded animals.** Our body temperature is generally 34°C. Even if the temperature of the surrounding

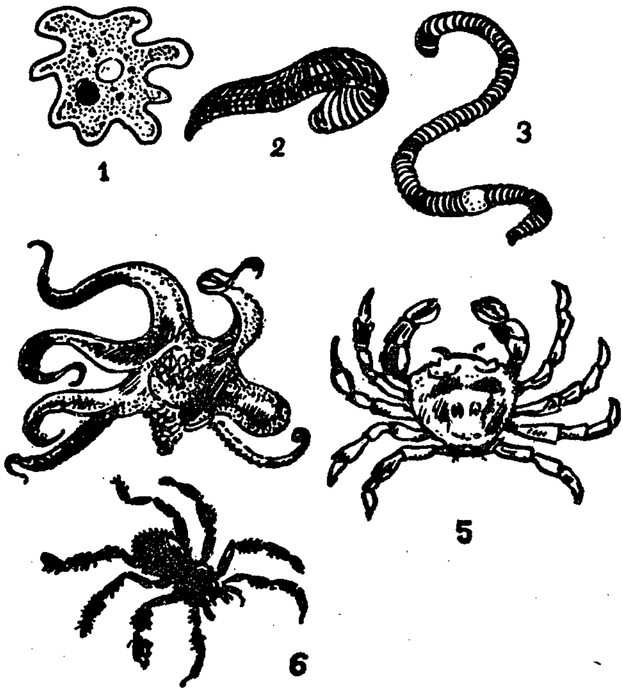


Fig. 106. (b) Invertebrates

1. Amoeba 2. Leech 3. Earthworm
4. Octopus 5. Crab 6. Spider

is very cold or very hot, our body temperature does not change. Find your body temperature using a clinical thermometer at different times of the day and night. Do you record any change?

QUESTIONS

1. Fill up the tabular column given below:

S.No.	Classification on the basis of food they take	Examples	Food they take
1.	Herbivores	1. 2.	1. 2.
2.	Carnivores	1. 2.	1. 2.
3.	Omnivores	1. 2.	1. 2.

2. Classify the animals given below on the basis of any two criteria selected by you.

   (a) Fish (b) Earthworm (c) Butterfly (d) Frog and (e) Parrot.

3. Write the differences between warm blooded and cold blooded animals. Give any two examples for each.

4. Write any three criteria for classifying animals. For each criteria give two examples. For each example give two adaptations and tabulate them.

For Thought

1. Give three criteria (which have not been discussed in this lesson) for classifying animals.

2. Find out two similarities and two differences between birds and reptiles.
3. On the basis of "Methods of reproduction" classify the animals known to you.

Exercise

1. Collect pictures of different animals and prepare an album. Classify the animals and also find out their special characteristic features.
2. Collect common insects (non poisonous) and prepare an insect box (ask your teacher to give you ideas).

2. KINDS OF PLANTS

We have already learnt that there are two major groups of organisms-the plants and animals. Plants are of many different kinds. There are so many micro organisms which are so small that it is difficult to see them with the naked eye. Bacteria is a distinct group of plants. They can be seen only under the microscope. The simplest plants, Algae are found in fresh water lakes, ponds, rivers and seas. There are many motile bacteria and Algae which can swim.

You have already learnt above two basis on which plants could be classified.

(1) Those which could be seen with the naked eyes.

(2) Those which could swim in water.

Plants can also be classified as follows:

(3) Plants living in water

(4) Plants living on land

(5) Plants which possess chlorophyll.

(6) Plants which bear flowers and fruits

(7) Non flowering plants

(8) Parasites and Saprophytes

There are different kinds of water plants (Hydrophytes). Some are found only in the seas. But here we shall study about plants growing in ponds, lakes and tanks only. Visit a nearby pond with your teacher and study the different types of plants living there.

(i) What are the special adaptations in the leaves?

(ii) How is the structure of the stem?

(iii) How is the root system?

(iv) What other special features are found?

In some ponds you might have seen the whole surface of water covered with water hyacinth. The flowers are produced in clusters. The roots are not in contact with the soil of the pond. The petiole is swollen and the air contained in it helps the plant to float in the water.

Some plants remain fully immersed in water. They are fixed in the soil at the bottom of the pond. The leaves and the whole plant body remain under

water. These are submerged plants. e.g. Hydrilla, Elodea, Vallisneria.

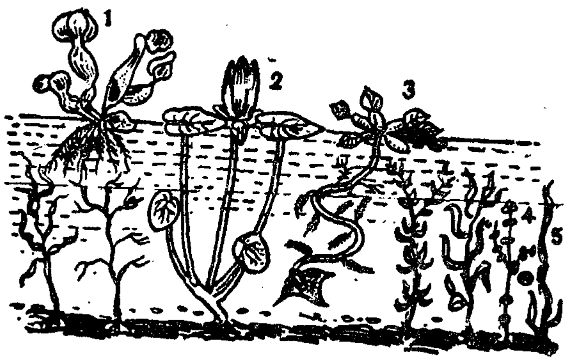


Fig. 107. A pond showing aquatic plants
1. Eichornia 2. Water lily 3. Trapa bispinosa
4. Hydrilla 5. Vallisneria

Lotus and water lily are common water plants. The plants are rooted in the mud at the bottom of the ponds. Flowers and leaves are raised above the water level.

Take some Hydrilla plant in a glass bottle immersed in water. Keep it in sunlight or in light from a table lamp focussed on it. Observe the

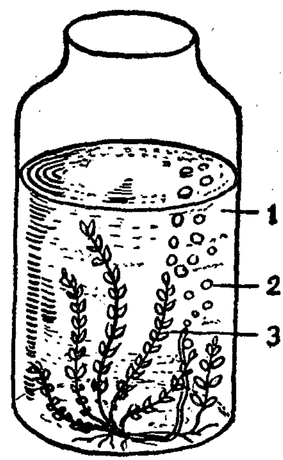


Fig. 108. Evolution of oxygen in the presence of sunlight
1. Water 2. Oxygen
3. Submerged plant (Hydrilla)

evolution of gas bubbles. What is the gas contained in these bubbles? From where did they come? What has happened? (You will study in detail about photosynthesis in higher classes).

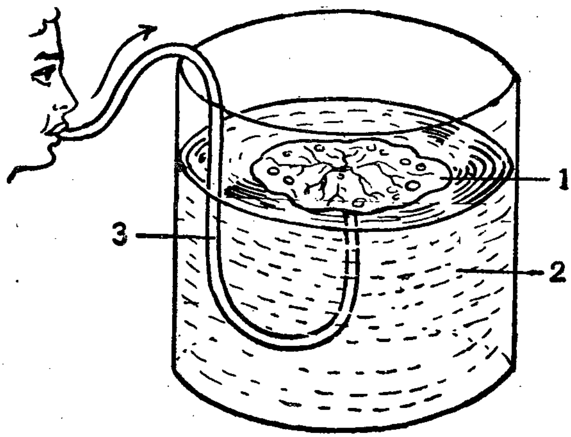


Fig. 109.
Air bubbling out through stomatal openings
1. Lotus leaf 2. Water 3. Rubber tube

Set up an experiment as shown in Fig. 109. Blow air into the leaf keeping your hand on the leaf so that it does not come above the surface of water. What do you see? Air bubbles are coming out from the upper surface of the leaf. What does this prove? Compare these bubbles with the bubbles of the previous experiment.

If you press the stem part of the submerged plants (keeping them under water), you can see bubbles coming out. From where do they come? How is the air in these bubbles useful to the plant? (You will study about respiration in plants in higher classes).

Some water plants grow partly in water and partly above the water surface. They are called Amphibious plants. The submerged leaves are much dissected and the leaves above the water surface are entire and normal (e.g. Limnophila). Why are the submerged leaves dissected? Find out.

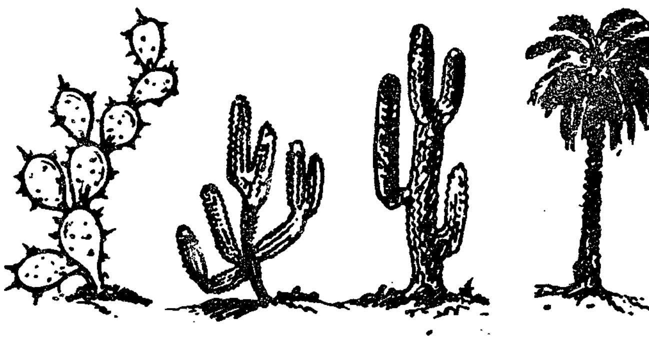


Fig. 110.

Desert plants

Some plants grow in dry regions. They are called **Xerophytes** (e.g. Cactus, Casuarina, Opuntia) What are the special adaptations in these plants?

1. How is the stem part?
2. Are leaves present?
3. If present, how are they?
4. Why do they possess hairs and thorns?

Rubber and pepper grow in very hot and humid places. Coffee and tea grow well in cold, hilly places. Some plants grow in places which are neither extremely dry nor wet. They are called **Mesophytes.**

They stand between hydrophytes and xerophytes. Give a few examples.

Take a piece of bread in a plate and sprinkle water on it. Cover it with a vessel. After a few days open it and observe with a magnifying glass. What do you see? You will see puffy (hairy) plants growing on bread.

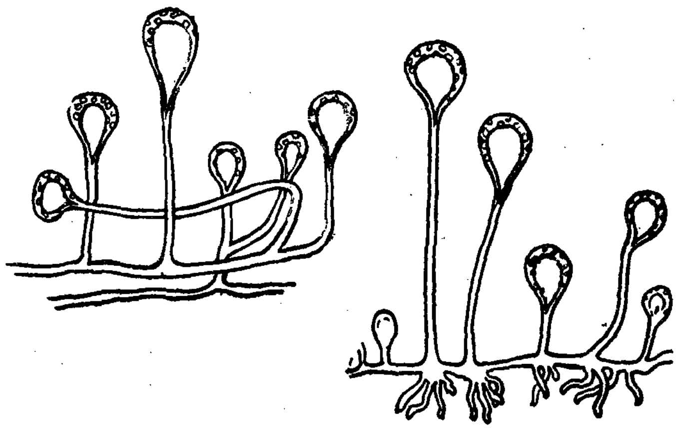


Fig. 111.

Mucor Rhizopus

This is the bread mould. Use the hair like structure and prepare a slide and see them under the microscope. What is its colour? They are colourless. These plants do not have chlorophyll. How do they get food? They feed on dead organic matter. Such plants are called **Saprophytes.** Can you give some more examples for this type of plant?

Have you seen the plant in Fig. 112? What is the name of the plant? Where do you find them? To which group do they belong?

Non-flowering plants are said to belong to lower plants in the plant kingdom. Algae, fungi and ferns are examples for lower plants. They do not bear flowers. Ferns are grown in the garden for their beautiful foliage. They are used to make flower bouquets. The fern plant has roots (rhizomes), stem (rhizomes) and leaves but no flowers. If you examine the under surface of a mature fern leaf, you may see brown spots. These brown structures



Fig. 112.
Mushroom (Agaricus)

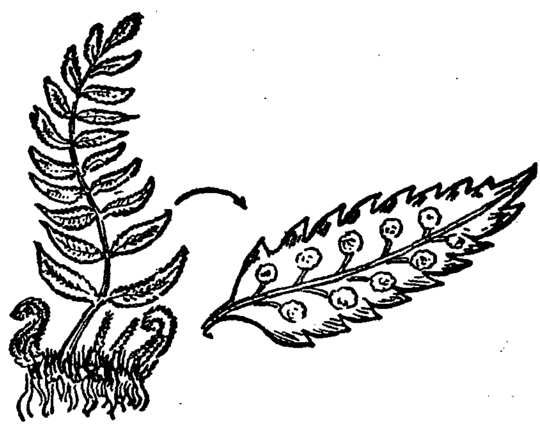


Fig. 113. Fern

can be clearly seen through a hand lens. They are called **Sori** (Fig 113). Each sori consists of a number of

box like structures. Each of this is a sporangium. Inside each sporangium there is a large number of spores. When the spores are ripe, the sporangium opens and the spores are shed. Each spore germinates and develops into a new plant.

There is another group of plants called as **Gymnosperms**. They produce seeds. In these plants, the seeds are not enclosed (naked) as in angiosperms. The pines and cedars belong to this group. They generally form part of the coniferous forests in higher altitudes in our country.

The pine tree produces two types of cones (male and female cones) during the reproductive phase.

Algae and fungi also produce spores for propagation. You might have seen certain plants growing perched on other plants.

Look at the plants which have grown on Bougainvilla and Neem tree. They are called **Parasites.** Cuscuta is a parasite. It lacks chlorophyll and it is dependent on other plants (host plants) for nutrition. It has a leaf less threadlike yellow stem. It

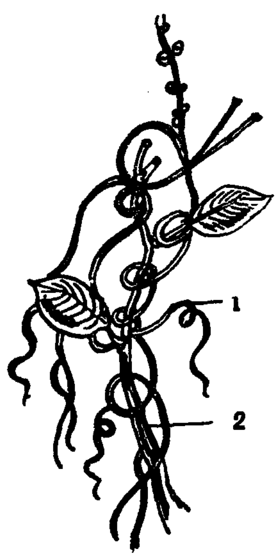


Fig. 114. A Total Parasite

1. Cuscuta 2. Host

grows on the branches of other plants and sends special absorbing roots called haustoria into the host plants to obtain the prepared food materials and water from them.



Fig. 115. A neem tree infected with Loranthus
1. Neem tree 2. Parasite 3. Haustorium

Some plants, such as Loranthus are green in colour. These plants are called partial parasites as they depend on the host only for raw materials (water and mineral salts) but manufacture their food through the process of photosynthesis.

QUESTIONS

1. For classifying plants mention two criteria which you have not studied in this lesson.

2. Describe the adaptations seen in lotus plants which live in water.

3. In the experiment done with the lotus leaf why do the bubbles come from the upper surface only?

4. If you do the first experiment described in this lesson in a dark room, oxygen bubbles will not be produced. Give reasons.

5. Classify the following plants using the tabular column given below:

   (It is necessary for you to observe the plants in nature or atleast sketches of them in a book). Name of plants: Water lily, Elodea, Vallisneria, Lemna, Eichornia.

Fully submerged water plants	Floating plants	Floating leaves with submerged stem and root and fixed in the soil

6. Where can you find plants such as Opuntia and Cactus?

   Find out their special features.

7. Why cannot Agaricus prepare its own food?

8. How does a Fern reproduce its own kind?

9. What are the differences between saprophytes and parasites? Give two examples for each.

10. Which of the following plants have chlorophyll: Spirogyra, Bread mould, Agaricus, Fern, Lotus.

For Thought

1. " The fungi including Agaricus cannot prepare food by themselves but still they are included as plants "—Give reason.

2. From which plant penicillin, a drug, is prepared?

3. When moistened bread is exposed to the atmosphere, how does the mould develop on it?

4. How do food materials get spoilt? What are the organisms responsible for this? How would you classify those organisms?

Exercise

1. Collect pictures of water plants and prepare an album. Write notes on each.

2. In small pots or used tins (with tiny holes at the bottom), put good soil and grow varieties of desert plants (Xerophytes). (You may use them for interior decoration in your house)

3. From your school garden, find out the names of common plants and classify them using a tabular column.

3. UNITY AMONG THE LIVING

We have learnt that there are different kinds of living organisms around us. There exist a large number of differences among them. For example- they differ in shape, size, habit, life span, structure of the body. etc. There are also a number of similarities between the different types of living organisms. Though living organisms differ in many respects at first glance, a closer study would reveal that both groups share the same phenomenon of life. We call this "Unity in diversity".

Let us find out the basic similarities in both plants and animals. You may find out some and compare with the list given below:

All living organisms can do the following by themselves:

(1) respire

(2) grow

(3) take in food

(4) break up food materials into simpler substances and release energy (This energy is used for various activities).

(5) repair worn out tissues

(6) respond to stimuli

(7) prepare the needed proteins in the cells

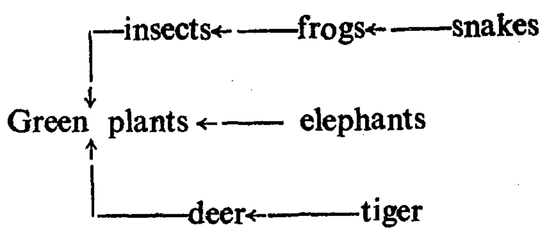
(8) reproduce.

You will be studying more about these life processes in the following chapters.

4. DIVERSITY AMONG THE LIVING

Living organisms are different from each other in many ways though they have many things in common. We are not going to study about the differences in general form or parts of the body. We shall take up certain common aspects.

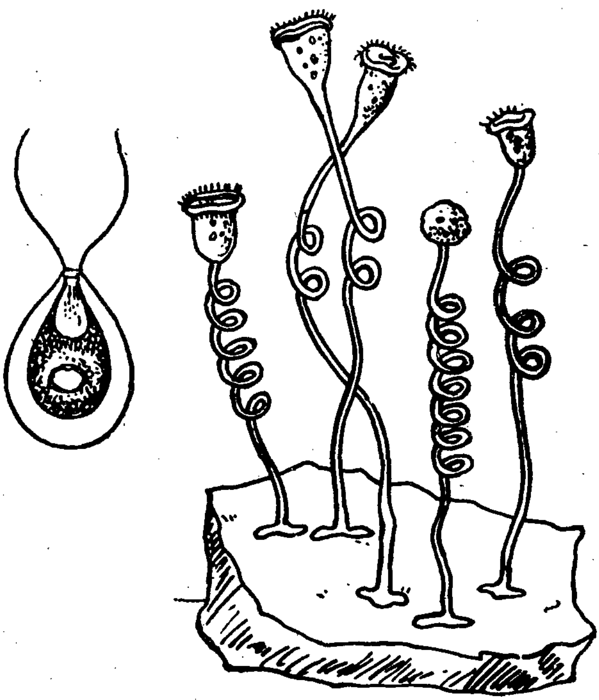
Since plants and animals are living organisms, they must nourish themselves. But the way they obtain their food differs in the two groups.



What do you learn from the above diagram? Animals and other living organisms depend directly or indirectly on green plants for their food. Green plants have the marvellous ability to prepare their own food. They have a green pigment called chlorophyll which can trap light energy and produce complex food—carbohydrate from simple substances such as water and carbon di oxide. This process is called photosynthesis. Excess of food material

is stored in seeds, fruits, stem, tubers, root etc. They are useful for other living organisms.

Plants do not move from place to place. They are stationary. Some plants, such as, **Chlamydomonas** are motile. They get the necessary raw



Chlamydomonas Fig. 116. Vorticella

materials from the atmosphere and soil but animals move from place to place in search of food, shelter and to escape from enemies. Some aquatic animals, such as **Vorticella, Obelia** and **Coral** remain fixed.

Generally, if a part of the body of an animal is cut off, it does not have the ability to regenerate

the lost part (but in lower animals like Hydra, Star-fish and Corals regeneration is possible). But rege-

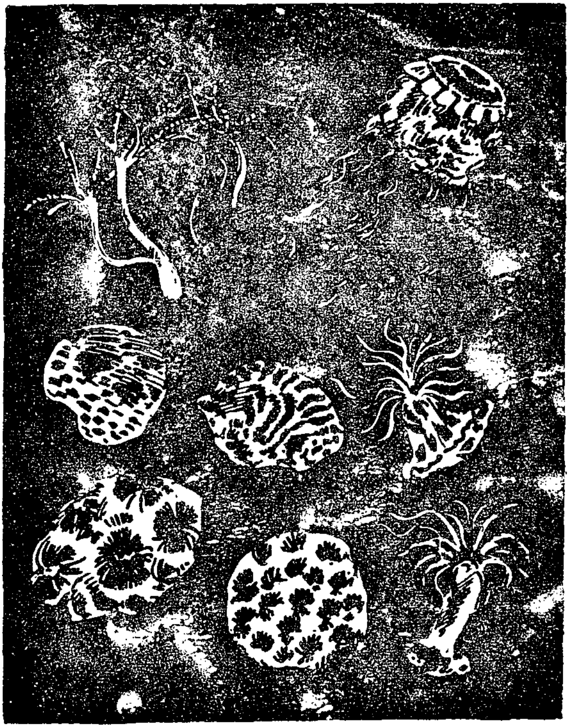


Fig. 117. Some marine animals

neration is seen in plants for e.g. sprouting of branches, and flowers from a cut trunk.

If a slice of a potato with an eye is planted in moist loose soil, the bud will develop into a shoot.

Growth in plants is more localised. It mostly takes place at the stem and root tips which consists of special cells (meristemmatic tissue) which can

divide rapidly. In animals growth is uniform and spread out all over, accompanied by an increase in size of the various parts of the body. Plants continue to grow throughout their life. Animals cease to grow after attaining maturity.

QUESTIONS

1. State two similarities and one dissimilarity between the one celled plant Chlamydomonas and the one celled animal Amoeba.
2. Plants are stationary. Animals move from place to place. Why?
3. Plants possess a unique substance which is absent in other living organisms. What is it? How is it useful to the plants?
4. What is the difference seen in the parts of a plant and an animal?
5. Draw two food chains not shown in your book.
6. What are the common characteristic features found both in animals and plants?

For Thought

1. Suppose all the plants disappear from our earth, imagine what would be the possible effects.
2. In aquaria, plants are grown—what kind of plants should be grown?

Exercise

1. Take a wooden box and put garden soil. Sow a few bean seeds and sprinkle water daily. Observe the changes that take place and note them down in a note book. Measure the growth in the shoot system. Discuss the data with your friends.

2. Keep a small potted plant inside a cardboard box. Put a hole (2 to 3 cm. diameter). Keep the set up exposed to light. In the nights, you can open the box and sprinkle water. Find out the changes in the growth of the plant. What are the reasons?

3. Pinch off the terminal bud from the branch of a plant, such as the rose or croton. Observe what happens in the lower parts of the stem. Discuss your findings with your teacher.

II. LEVELS OF LIFE

5. DIFFERENT LEVELS OF LIVING ORGANISMS

What is life? The term 'life' is difficult to define. How did life begin? Have there always been living organisms on this planet? We do not know the answer.



Fig. 118.

Virus particles

(Very much enlarged)

There are very tiny things called **Virus.** They are much smaller than the smallest bacteria. They have a definite shape. It consists of a core of nucleic acid surrounded by a sheath of protein. It is a molecular aggregate of nucleic acid and protein. They have no cytoplasm, nucleus or cell membrane. Virus crystals can be stored in bottles, just like sugar or salt.

Tobacco mosaic virus which causes diseases in tabacco plants can also be crystallised. This is a property of chemical substances. If these crystals are dissolved in water and smeared on the leaves of a healthy tobacco plant, it will show symptoms of the viral disease. If a virus particle is introduced into a suitable living cell, after some time a large number of virus particles can be seen in the cell. They multiply rapidly within another living system. They have the capacity to duplicate themselves accurately. It is a great puzzle to the biologists. They do not know whether to place it with living organisms or non-living things. They have placed it on the border line (a link) between living and non-living.

Cells	Living state
Molecular aggregate	A link between living and non-living (Virus)
Molecules Atoms Minute particles in an atom	Non-living state

All living things are made up of one or more tiny structures called cells. These are the structural and functional units in living organisms. The first level of life is the **cell**.

The inside lining of your cheek is a nice material to observe cells. With the blunt end of a toothpick,

scrape off some of these cells and place them on a glass slide. Put a cover glass over it and mount it in

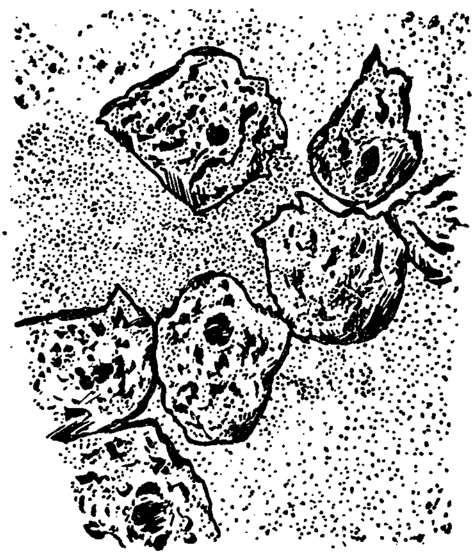


Fig. 119. Cells from the scraping of human cheek (animal cells)

water and observe it under a microscope. You can see many cells with their limiting membrane, cytoplasm and nucleus.

Take an onion peel from the inner surface of its scales, put one or two drops of water on a clean slide and place the thin membrane in water. Arrange the peel in the water so that it has no folds. Put the cover glass and observe the peel under the microscope. It consists of many cells closely packed. Each cell has a cell wall and a lining of thin plasma membrane. Inside the cell there is a jelly like liquid called **Protoplasm**. In this protoplasm there is a

denser, spherical body called the **Nucleus.** The liquid outside the nucleus is called **Cytoplasm.** An

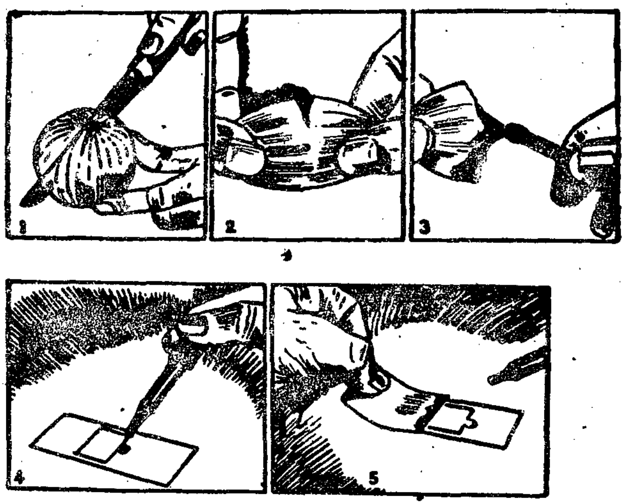


Fig. 120.

Different stages in the preparation of a slide of onion peel

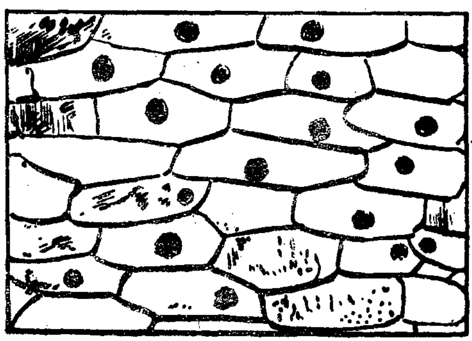


Fig. 121. (a)

Cells as seen in the epidermal peel of onion

animal cell does not have a non-living cell wall. Some organisms are composed of only one cell and the

different parts of the cell perform different functions. The bodies of large organisms consists of millions of cells but the cells are specialised according to their functions. A group of cells specialised for

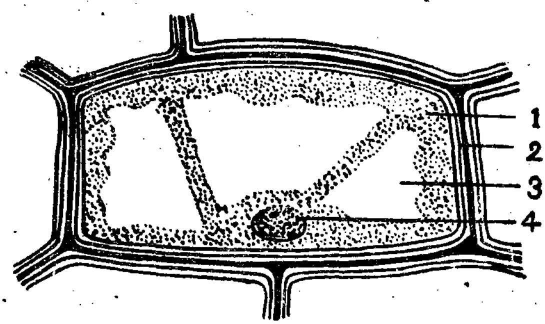


Fig. 121. (b) An enlarged cell

1. Cytoplasm 2. Cell wall
3. Vacuole 4. Nucleus

a particular function is called a **Tissue.** They not only perform the same function but also are similar to each other in form, structure and other features. Each tissue will have its own characteristic features and specific function. **Tissue** is the second level of life.

Two or more kinds of tissues may be associated together to form an organ, which is a specialised part of the body, performing some specific functions or function. Several kinds of tissues are closely associated as part of one structure and functions in an interdependant manner. There is a division of labour in the different tissues that are part of an organ. All the cells and tissues are controlled by

D.N.A. which is a nucleic acid. It directs growth and other activities in an organism. It determines the nature of a cell and therefore the whole organism, as to what it should become and so on. D.N.A. performs its functions in a very wonderful way. **Organ** is the third level of life.

A group of related organs performing a common function is called an organ-system. Several organs of a system form a particular system. For instance the excretory system consists of several organs like kidney, skin, lungs and large intestines. Each organ has its own function but altogether they perform a common function. **Organ system** is the next level of life.

Lastly a group of organ systems working together constitute an **organism**. It is really thrilling to know all this, the cells, tissues and organs working together and forming their function day and night. There is orderliness in the living world. When this orderliness is disturbed the cells of a particular organ do not function properly, and the entire body suffers. God's creation is marvellous!

Let us arrange the living and non-living things in an order:

Living organism ↑ Organ system ↑ Organ ↑ Tissues ↑ Cells	} Living state

Molecular aggregate } In between living and non-living
↑
Molecules }
↑ } Non-living state
Atoms }

When we consider deeply the life of organisms relating to their environment, we find that there are some levels. You can find out the different levels by studying the diagrams given below:

World biome
↑
Community
↑
Family
↑
Species
↑
Living organisms

QUESTIONS

1. Give reasons to state that virus is a non-living thing.
2. When and how does virus show its living nature?
3. Name three unicellular organisms?
4. Draw an animal cell and a plant cell. Name the parts.
5. What is a 'tissue'?

6. Arrange the following in the ascending order (1) organ (2) organisms (3) organ system (4) tissue and (5) cell.
7. Name the organ systems in your body and write the organs in any one organ system.

For Thought

1. How could life have evolved in earth?
2. Mention the similarities and differences between a plant cell and an animal cell.
3. A man was pronounced dead. But cells and tissues in his body in certain parts did not die!

   Analyse this statement (relate this to grafting the heart or the lungs from a dead human body to a needy living individual).

III. LIVING AND NON-LIVING

6. DIFFERENCES BETWEEN LIVING AND NON-LIVING

On your way to school you see many things. Which of these are living and which are non-living? All things in the world can be classified into two major groups-living and non-living. You have learnt some of the important features by which you can distinguish living from non-living.

Let us think about some man made machines; compare a motor car and an animal. Is it wrong to say that the car is living? Examine this statement.

You might have heard about the recently invented computer. It can quickly perform the various complicated functions. Man has made it. Some people say that the computer is more powerful than the human brain. But the computer can do only the function for which it has been programmed by man. Human brain has the ability to produce new ideas and to discover new things. Man has the capacity to think.

Non-living objects cannot take in food and release energy which is used for various activities (Metabolic activities are not found in them). Non-living things do not produce more of their own kind.

There are many lifeless things in the body of a living thing. They can be differentiated into liquids and solids. Water is very important. Protoplasm which is a unique living thing has water, mineral salts, carbohydrate, fat, protein and nucleie acids. Can we make living protoplasm by mixing these substances? So far the answer is 'No.' Protoplasm has all the characteristic features of a living thing. If a cell is not able to perform the life activities properly it suffers from various disorders. If the life activities are not seen in it, it is said to be dead.

Nucleic acids are another kind of organic compounds found in the protoplasm of all living cells. There are two types of nucleic acids, the ribo nucleic acid (R.N.A.) and the deoxyribo nucleic acid (D.N.A.)

DNA is a long, unique molecule. It is capable of making an exact duplicate of itself. In the cytoplasm of a cell, protein synthesis takes place, under the instructions given by DNA of the nucleus. This is a very exciting discovery. This discovery is among the most significant biological advances of all time.

You will be wonder struck when you study in detail about DNA and RNA in the higher classes.

QUESTIONS

1. State the similarities and differences between living and non-living things?
2. What are the differences between a running motor car and running dog with reference to deeper scientific concepts?

3. Why cannot the computer be used in the place of human beings?

4. Name three non-living things found in living organisms.

5. Write the expansion of RNA and DNA.

6. What are the important features ot DNA?

IV. METABOLISM

7. METABOLISM

In a living organism, a number of chemical reactions are always going on in the cells. Energy is needed for these activities. You have already learnt that the food materials have stored-up energy. This energy is released and used by the living organisms. Without food materials, living organisms cannot exist. The living organism should

1. release the energy from the food taken in

and 2. use the energy for its varied activities.

Some amount of energy is used for various life activities and some amount is used for the growth of the organism itself.

Study the chart given in Fig. 122.

The food materials are first broken down to release energy. As the breaking down process is going on, simultaneously there is also the process of building up. Both the break-down and building up process together constitute the process of **Metabolism**. Every living organism has the capacity to metabolise by itself. This is a very important characteristic feature of all living organisms.

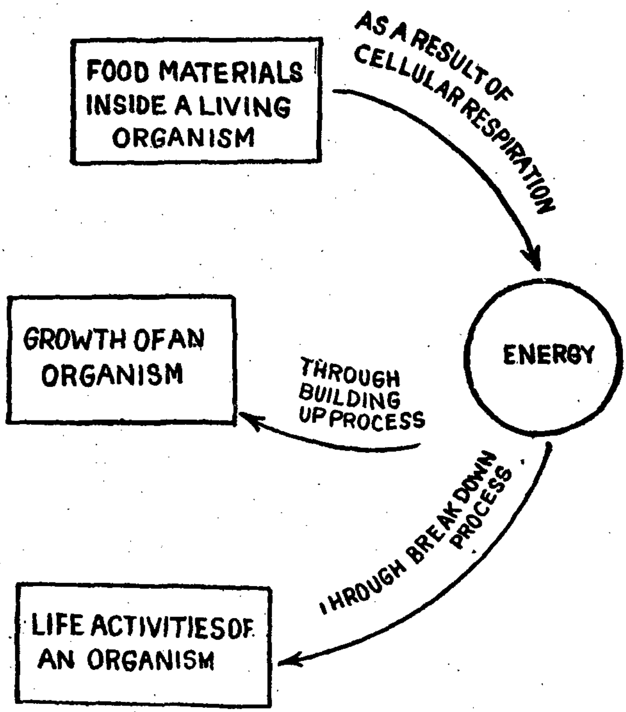


Fig. 122. Scheme for Metabolism

We can analyse metabolism into two parts.

(i) **Catabolism**

and (ii) **Anabolism**

These two functions, are closely related continuous process. We should not think that first catabolism will take place and after that anabolism will take place.

In metabolism, the carbohydrates are used as fuel for respiration taking place in the cells. Energy

is released during respiration. That energy is usep for building up the protoplasm in the cells. The protoplasm that is formed is used for the formation

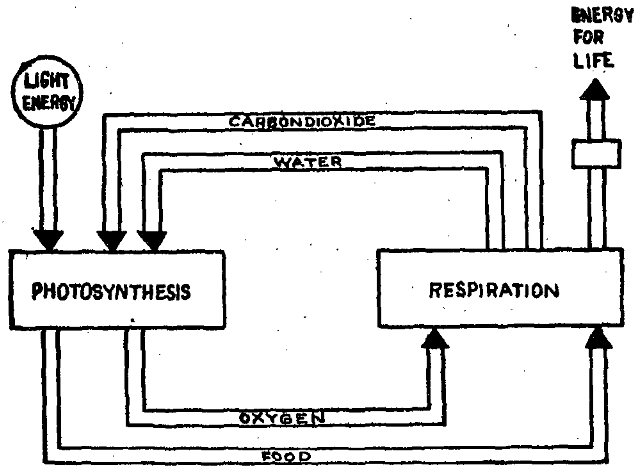


Fig. 123.

Sketch to show the relationship between Respiration and Photosynthesis

of raw cells. The required proteins are synthesised with the available **amino acids** utilising the energy. Many types of proteins could be synthesised using the amino acids as the basic unit of construction. The protein molecule is a long chain of amino acids. In nature, 20 amino acids are available.

Analyse the chart given in Fig. 124 and see how proteins are synthesised.

During catabolism, energy is released from carbohydrates.

Glucose (Sugar) +Oxygen ⟶ Carbondi oxide + Water + Energy

In the cells, glucose is broken down through the process of oxidation and energy is released. Carbon di-oxide and water are the by-products.

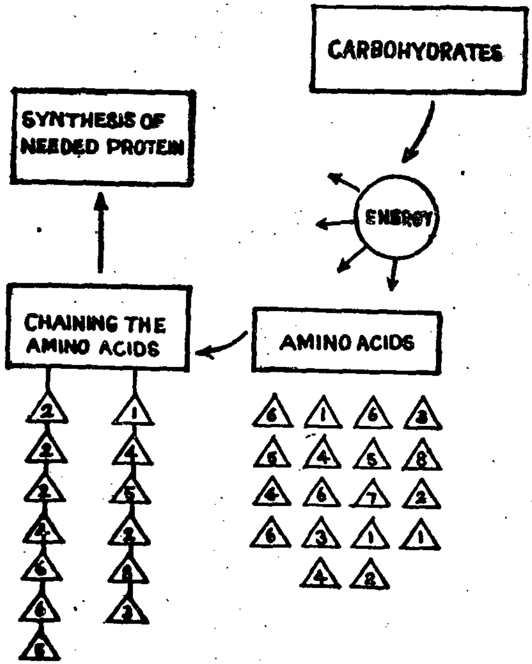


Fig. 124. Protein synthesis

The energy that is released is in the form of an energy rich compound **Adenosine Triphosphate** (ATP). ATP is the biological energy which is in a usable form for the living organisms. ATPs are generated by **Mitochondria** that are present in the cell. Therefore, mitochondria are described as the 'power house' of the cell.

If anabolism has to take place, catabolism is necessary. So also, if catabolism has to take place

anabolism has to take place. As you have learnt earlier, both processes are interconnected.

Preparation of Food Materials by Plants themselves

In nature, green plants utilise the freely available light energy from the sun, water from the soil and carbon-di-oxide from the atmosphere and prepare carbohydrates. This biochemical process is called photosynthesis. If this process does not take place, there will be no food available on the earth. Millions of green plants are preparing tons of food every second! In our country, scientists are doing research in laboratories on various aspects of photosynthesis.

Photosynthesis generally takes place in green leaves. Can photosynthesis take place in any other part? If so, under what conditions? Think.

The following are essential for photosynthesis to take place:

(1) chlorophyll present in living chloroplasts.

(2) water

(3) carbon-di-oxide

and (4) light energy

Suppose you keep "chlorophyll", water, carbon di oxide in a vessel and expose to light, will carbohydrate be formed? Think. Why cannot carbohydrates be manufactured?

In living plants, there are a number of enzymes. Enzymes are also necessary for photosynthesis to take place.

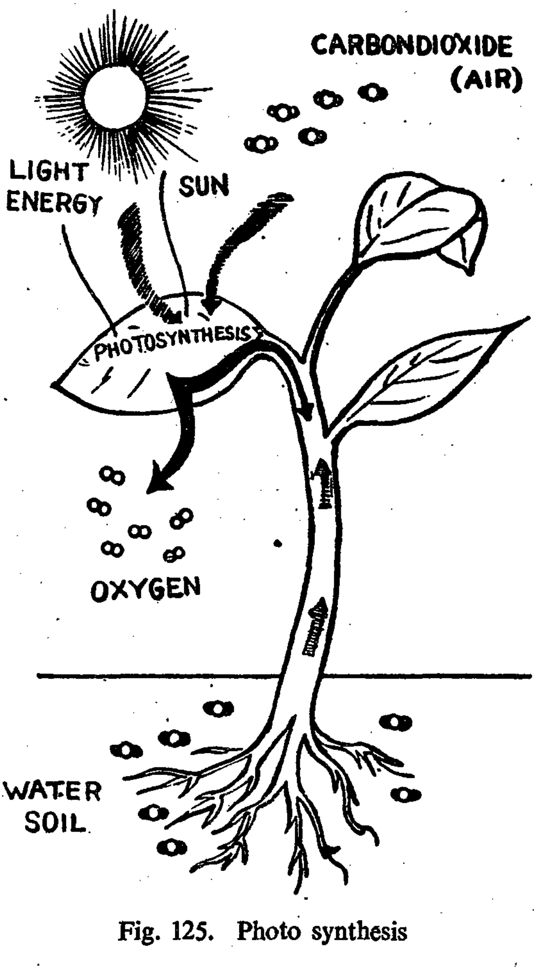


Fig. 125. Photo synthesis

During photosynthesis, the light energy is converted into chemical energy and stored in carbohydrates. It is really a wonder that green plants have a device to convert the freely available solar energy

into useful chemical energy and stores it as food materials for our benefit.

$$\text{Carbon di oxide} + \text{Water} \xrightarrow[\text{Light energy}]{\text{Chlorophyll}} \text{Glucose} + \text{Water} + \text{Oxygen}$$

Experiment 1

Dissolve a small amount of rice or wheat powder in water in a test tube. Then add 2 or 3 drops of iodine solution and shake it well. Record the colour changes. This is the test for starch.

Experiment 2

Pluck (in the afternoon), green leaves from a plant (e.g. radish or bean) exposed to light. Test them for starch as follows:

(a) Keep the leaves in boiling water for a few minutes to kill and loosen the tissues.

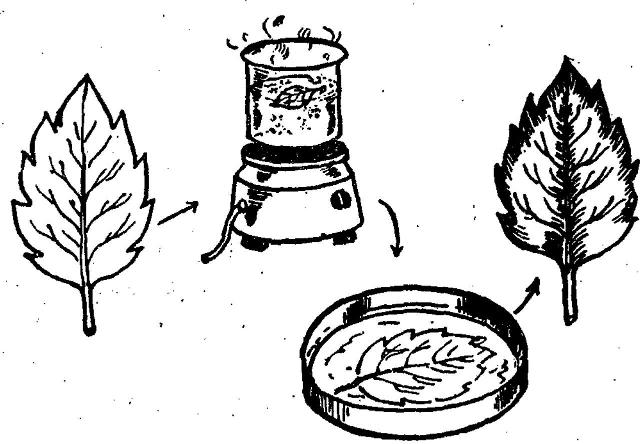


Fig. 126.
Test for starch

(b) Put the leaves in ethyl alcohol in a beaker and boil for a few minutes on an electric heater or in water bath (Do not heat ethyl alcohol directly over an open flame). The chlorophyll will dissolve in alcohol and the leaves will become colourless.

(c) Wash the decolourised leaves in water and keep them in watch glasses or petri dishes and put a few drops of iodine solution on each. Record what happens. If it turns blue in colour, what can you infer? (Refer the findings of the previous expt.)

Materials necessary for animals to live

From where do animals get their food? The ultimate source is the green plant.

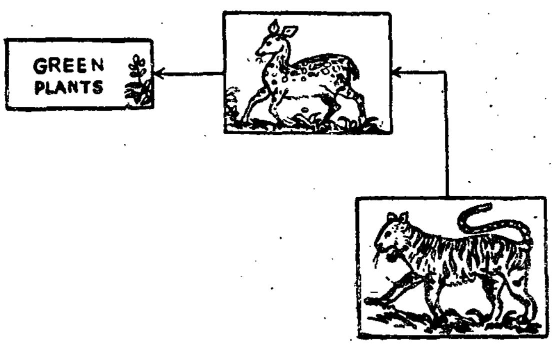


Fig. 127. A food chain

From the above food chain, you can say that there are two types of animals.

1. those animals that directly depend on plants for food.

and 2. those animals that indirectly depend on plants for food.

Compare herbivores and carnivores with the above classification.

If the deer does not feed on green plants, tiger cannot survive! The green plants are the basic food material on which all animals depend either directly or indirectly. Animals can not prepare their own food like green plants.

The food eaten by animals and the oxygen taken in during respiration react releasing energy. The energy is used for making proteins which are an important part of the protoplasm. The waste products such as carbon di oxide are thrown out! Thus we see that anabolism and catabolism are seen as parts of an integrated process called metabolism.

Characteristics of metabolism

1. This can take place only in living organisms.
2. As a result of metabolism, new cells are produced.
3. ATP is necessary for metabolism.
4. In anabolism, the chemical energy is transformed into ATP which is usable form of chemical energy.
5. All activities that aid towards self perpetuation may be described as metabolic activities.

QUESTIONS

1. What is metabolism?
2. How are proteins prepared by plants?
3. What are the raw materials used by plants for preparing food materials?
4. What is photosynthesis?
5. Describe an experiment to test for starch in leaves.
6. What are the factors essential for photosynthesis to take place?
7. What are the differences between anabolism and catabolism?
8. What is ATP? How is it useful to the organisms?

For Thought

1. "The light that falls on plants is responsible for food in the world"— Explain.
2. If, in our body, catabolism is at a faster rate than anabolism, what may be the possible result?
3. Find out groups of plants that are not able to perform photosynthesis. From where do such plants get their food?
4. Green grasshopper and green chameleon are not able to perform photosynthesis. Give possible reasons.

5. If an animal can perform photosynthesis, wha+ uld be there in its structure?

Exercise

1. .ınd out the substances that are present in onion, tomato, plantain, carrot, potato and radish by doing experiments.
2. Pluck leaves from the same plant at different times in a day, and test for starch. Interpret the results.
3. Select a variegated leaf from a croton plant and find out which portions contain starch.

V. IRRITABILITY

8. STIMULI AND RESPONSES IN PLANTS AND ANIMALS

All living beings have irritability. They respond to stimuli. The ability to respond to an external stimulus is a basic property of the protoplasm. Both plants and animals possess this property. There are various types of stimuli from the environment which act upon the organisms continuously. A stimulus is one which is able to provoke a response in an organism. Irritability is the ability of an organism to respond in an appropriate manner to a stimulus.

Stimuli may be external or internal. For example, the stimulus may be bright light, smell etc. Here the stimulus is external. The flowers of some plants turn towards the source of light. Certain insects also move towards light.

If somebody pricks you with a pin, what is your reaction? This can also be explained as response to a stimulus.

Take two pots with tender plants. Place one pot with the plant in the horizontal position. Observe carefully. The stem of the plant which is kept in the horizontal position curves and grows upwards. What do you learn from this? Gently pull out the plant from the soil and see which way the root is

growing. In what way is it different from the stem? Why do you think the root and the stem grow in the opposite directions? The stem grows away from

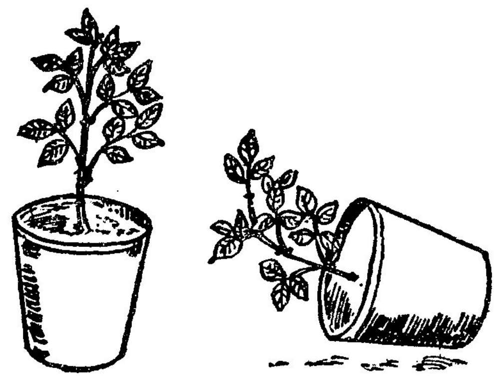


Fig. 128. Geotropism (Positive and Negative)

gravity and roots towards gravity. This curvature is caused by the activity of **auxins**. These are chemical substances which regulate growth.

Put a few flies in a beaker. Are they affected by gravity? So, we know that gravity is not a stimulus for flies.

Take a phototrophic chamber. It consists of a rectangular wooden box painted black on all sides

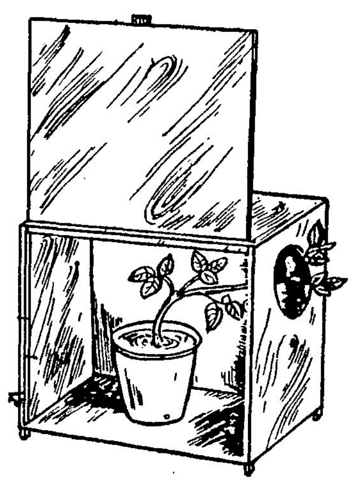


Fig. 129.
Positive phototropism

with a small opening on one side for light to pass through. Keep a potted plant inside the chamber and another potted plant outside. After a few days you see the stem tip curves and grows towards the opening. The stem of the plant which is kept outside grows straight. Which is the stimulus? Can light affect the root system? Find out.

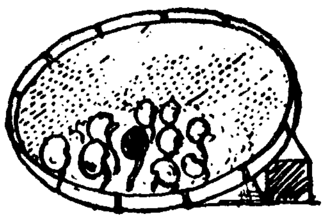


Fig. 130.
Experiment to demonstrate hydrotropism

Take a sieve containing moist saw dust. Grow a few soaked bean seeds in the sieve. Keep the seive in a slanting position. The concentration of water will be greater in the lower half than in the upper half. Observe the growth of the roots. In which direction do they grow first? Afterwards why do the roots grow along the seive? Find out the reason for the change in direction.

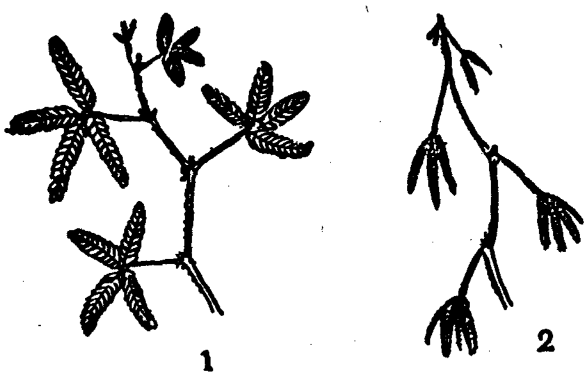


Fig. 131. Sleep movement
Mimosa (sensitive plant) Leaves in normal position
Leaves folded on touch

You would have seen the plant called "Touch-me-not" (Mimosa pudica). The leaves of the plant fold up when touched by hand and open again after some time. If the tip of a leaf-let is touched, what happens? Touch the main rachis and see what happens? When you touch one leaflet, the leaflets nearest to that close and this is followed by the closure of adjacent leaflets one after the other. Which is the stimulus here? The following are some of the important stimuli which affect the animals:

(1) heat

(2) chemical substances

and (3) light

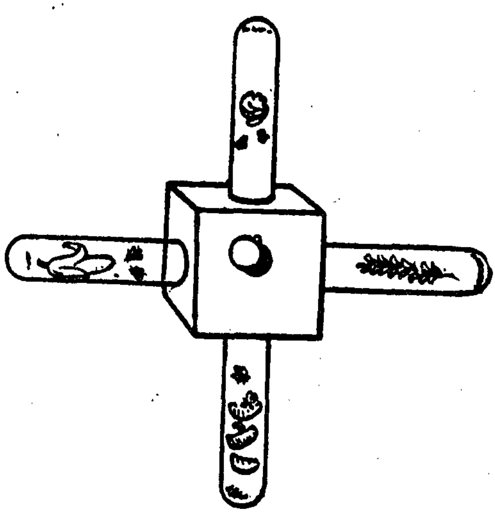


Fig. 132.

Which chemical substance is liked most by flies?

Take a box with five holes as given in Fig. 132. Fix four test tubes in the side holes. Put a piece of plantain, little sugar, few curry leaves and a piece

of orange in each of the test tubes. Catch a few fruit flies and insert them through the upper hole and close it. Observe towards which test tube they move? Which is the stimulus? All are chemical substances. So find out which chemical substance do the flies like most.

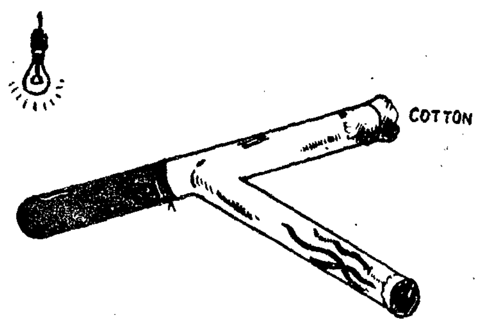
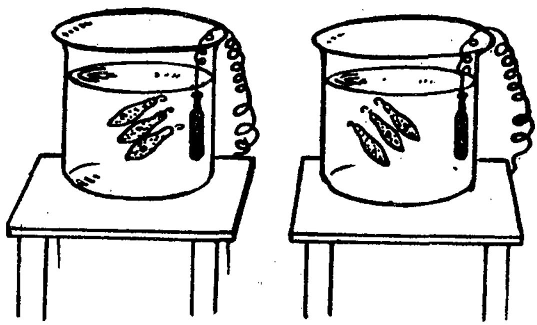


Fig. 133.

Experiment to show the sensitivity of the earthworm to the intensity of light

Take a glass tube as shown in Fig. 133. Wrap one side of the upper limb with black paper. Plug both the ends of the upper limbs with cotton. Insert four earth worms through the lower end of the stem and plug it with cotton. Keep the T. tube horizontally in sunlight or under a lamp. Take care not to disturb the set up. Watch the movements of the worms and note where they finally settle. What do you infer from this experiment?

If a vessel containing Euglena is warmed on oneside, the Euglena will move towards the warm side and respond to heat. But when the water becomes hotter on that side, they move away from there. What is the stimulus for this movement?



1. At a low temperature Fig. 134. 2. At a higher temperature
Response of Euglena to Heat

During rainy season, earthworms are found on the surface of soil. But during summer they are underground. Give few other examples like earthworm. Non-living things do not show irritability. When sulphur powder is heated, it undergoes complete change. But when light falls on living earth worms they creep into the soil and there is no change in its form. So, all living organisms are sensitive to the surroundings and react to them.

QUESTIONS

1. What is meant by irritability?
2. Describe an experiment to show that stems grow against gravity.
3. How are plants affected by light stimulus?
4. What is the stimulus which brings about the closure of the leaves of "touch-me-not"?
5. "Animals also respond to light". Explain this with an experiment.
6. State the difference between the responses to stimuli in living and non-living things.

VI. MOVEMENTS IN LIVING ORGANISMS

9. MOVEMENTS OF ANIMALS

There are various kinds of movements in living organisms. Animals move from place to place. They run, walk, swim, hop, fly etc., but plants and some lower animals are stationary and show movements of certain parts only. Though plants remain fixed to the ground, they show movements due to specific stimuli from the environment.

Plants do not have to move from place to place (certain lower plants are motile) as they get their raw materials from the soil and the air around. But animals go in search of food and shelter and also to escape from their enemies. So they possess special structures for movement. Depending upon the environment and body form, they have definite organs for locomotion. Let us study about the movement of few animals.

After heavy rain, you can see earthworms crawling on the ground. Observe an earthworm closely when it is moving. Its body is made of rings. It does not have bones and legs. There are small fine bristles on the lower side of the body. They are called **setae**. The earthworm holds the ground with

the help of the setae. It extends its front end and holds the soil with the setae and the hind end is drawn forward. The setae on the hind end serve as anchors as the front end is extended. This process is repeated again and again. Its movement is by the contraction and relaxation of its body muscles.



Fig. 135.
Earthworm

We very often see how lizard walks on the walls in our homes during summer. Observe a house lizard running on the walls and on the ceiling. How does it manage to stay there? Why does it not fall? It has two pairs of limbs. Each limb has five toes and sharp claws. Examine the toes of the lizard carefully. What do you see? There



Fig. 136. A garden lizard

1. Food 2. Claw
3. Toes 4. Cup-like depressions

are minute cup-like depressions (suckers) at the ends on the toes of the limbs. These depressions are

pushed against the surface of the wall on the ceiling and then loosened. Vacuum is created inside and the animal is kept adhered to the surface by the atmospheric pressure from outside.

Snakes do not have legs. They have a number of scales packed closely on the lower surface of its body. Its vertebral column is long and made up of a number of vertebrae. Each vertebra has two ribs which are connected by ball and socket joints.

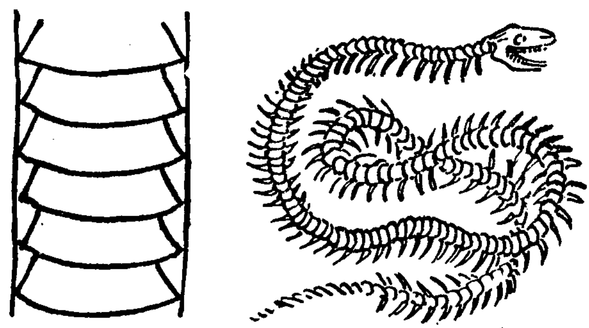


Fig. 137.

Scales Skeleton of a snake

Because of this arrangement, it can move and bend as it goes. The ribs are connected to the scales by muscles. These muscles help in locomotion. Can you find out a reason why snakes are kept in glass cages in the zoo?

Fishes are adapted to live in water. Its body is flattened at the sides and tapered at the ends. It looks like a boat. It has fins that help in swimming. Look at the picture of a shark. There are different kinds of fins placed at different positions on the

body of the fish. You will observe a pair of fins behind the gills. These are the pectoral fins. Similarly you will find that there is another pair of fins on the ventral side. We call them the pelvic fins. At the hind part of the body on the dorsal side there

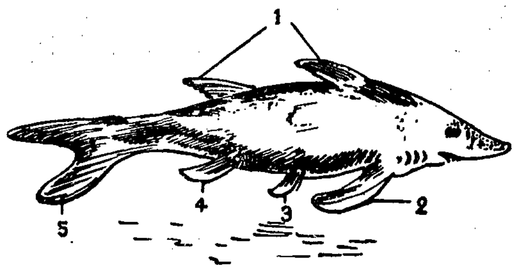


Fig. 138. Shark

1. Dorsal fins 2. Pectoral fin 3. Pelvic fin
4. Anal fin 5. Caudal fin

are the dorsal fins. The fin at the tail is the caudal fin. Observe in your aquarium the movement of the fins of a fish. The dorsal, pelvic and tail fins balance the body and do not allow it to topple. The pectoral fins help a fast moving fish to stop suddenly by spreading out the fins. The tail fin is like a rudder of a boat in steering the body of the fish during its swimming.

It is fascinating to watch the way birds fly in the air. Some birds walk, some birds hop. Almost all the birds can fly in the air. Do you know any bird that cannot fly in the air? The fore limbs are modified to form wings in birds. There are certain muscles connecting the wings to the breast bone. It is the contraction and expansion of these muscles

that keep the wings moving upwards and downwards. By flapping its wings, the air is pushed backward

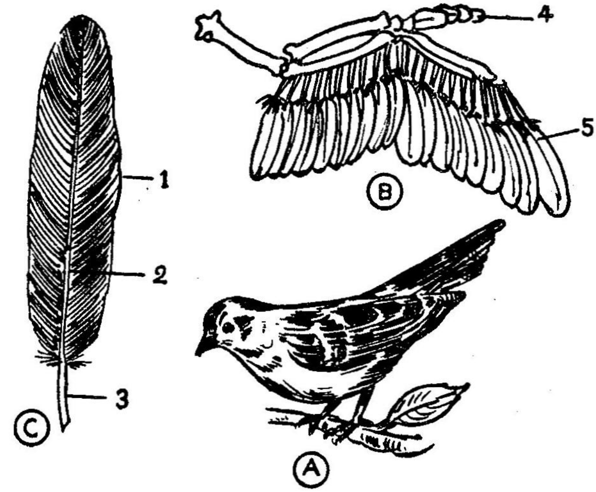


Fig. 139.
Structure of the feather of a bird
1. Barbs 2. Vane 3. Quill 4. Bones 5. Feathers

and the bird is able to fly upwards and forwards. The tail feathers help in changing the direction. It is like a rudder. The bones are light, hollow, and spongy.

10. MOVEMENTS OF PLANT ORGANS

You have already learnt about the movement of the parts of the plants in the lesson on "irritability". Light, heat, water and gravity are a few stimuli in the environment. You know the responses to these

stimuli. You have also learnt how sleep movement takes place in touch-me-not plant.



(a) Fig. 140. (b)

Sleep movement in the leaves of Rain tree

(a) During day time (b) During night the leaves are folded

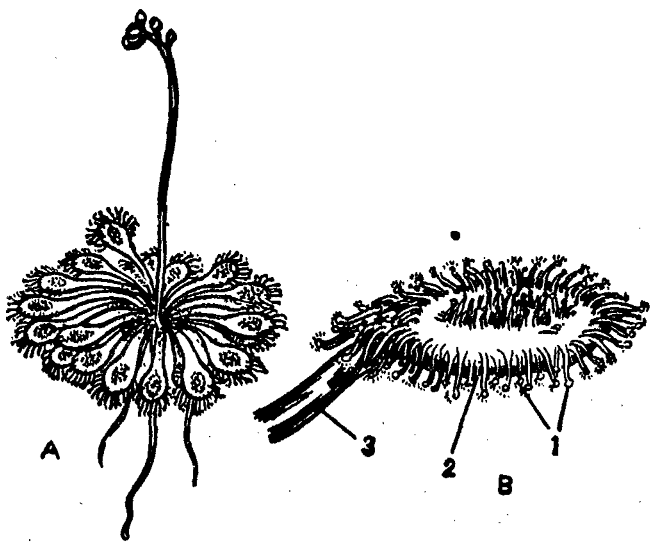


Fig. 141. Drosera

(A) Whole plant (B) A leaf showing the tentacles in normal position

1. Glandular hairs 2. Surface of the leaf blade 3. Petiole

The leaves of the rain tree fold and hang down during night time as though in sleep but they assume their normal position again in the morning. This is also an example for sleep movement. You might have observed the opening of the flowers of lotus or water lily in the early morning and closing during the day.

Drosera is an insectivorous plant. The leaf blade has peculiar tentacles with glandular hairs at their tips. When small insects sit on the surface of the leaf, the tentacles bend down upon the visiting insect and tear it. There is external digestion and the plant feeds on it (Fig 141).

QUESTIONS

1. Which are the parts in earthworm that help in locomotion?
2. Explain how the house lizard is able to move in the ceiling in the house.
3. Why are the snakes not able to move on glass surfaces?
4. Explain the locomotion in snakes.
5. Describe how the fish is able to swim.
6. How are birds adapted to fly in the air?
7. Explain the function of the tail in birds.
8. What is sleep movement? Name the plants in which it is seen?
9. Give examples of flowers which show sleep movement.

10. Mention the differences between the movement in animals and movement in plants. Give reasons for the differences.

For Thought

Suppose you keep a phosphate, or albumin or any other substance in the middle of a leaf of drosera, what would be the reactions?

Exercise

1. Keep a live earthworm on a piece of paper. Keep your ear on one end of the paper and listen to the sound produced. You can feel the body of the earthworm for setae.
2. Observe the legs of the house lizard and find out details.
3. Find out details about the aquarium fish.
4. Visit the zoo and collect details about a few kinds of snakes and birds.
5. Observe the "rain tree" at noon and late in the evening—Note the changes in the leaflets and leaves. Discuss with your teacher.

VII. GROWTH

11. GROWTH

All living organisms keep on growing as long as they live. All living organisms, both plants and animals, grow. It is an important characteristic feature of living things. However, there is a marked difference in the nature of growth in plants and animals. Plants continue to grow throughout their lives. Animals, on the other hand, stop to grow after attaining maturity.

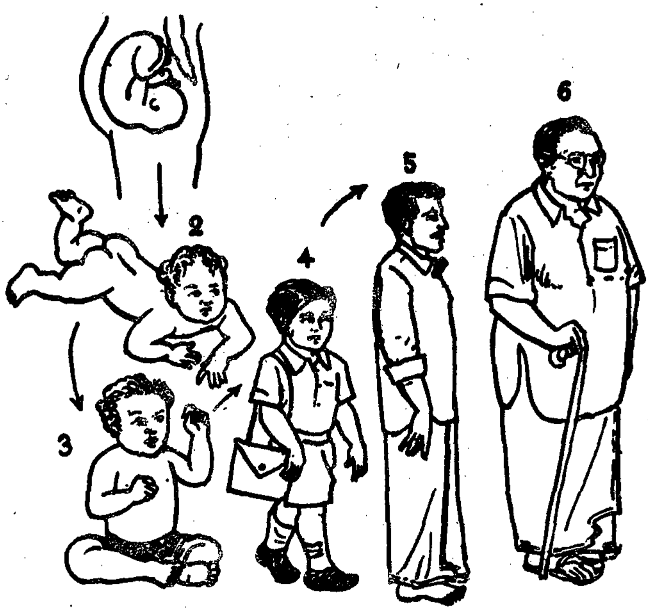


Fig. 142. Different phases of human life

Living organisms grow by taking substances from their surroundings or from other living things and combining these substances in various ways and finally converting them into the materials of their own body. In short, growth is the result of metabolism.

Factors necessary for growth

Several internal and external factors influence growth.

(1) The ratio between carbohydrates and nitrogen compounds.

(2) Mineral salts are necessary (carbon, nitrogen, phosphorus, sulphur etc.).

(3) Growth is controlled by the nucleus in the cell particularly the DNA molecules in the nucleus.

(4) Energy (ATP molecules).

(5) Growth is regulated by certain chemical substances known as auxins.

(6) Vitamins play an important role in growth.

(7) Water is necessary.

Growth is a complicated process. It is not merely increase in size. Such a type of growth is seen in non-living things also. A crystal of copper sulphate when suspended in its own saturated solution increases in size. This takes place as a result of addition of more particles (molecules of copper sulphate) from the outside. Growth in living organisms comes from within. It is self-growth.

It is the disease that prevents the living organisms to grow and develop. Generally, when the animals are sick, they go in search of medicinal plants available in nature. Have you seen the dog eating medicinal plants sometimes? It eats those plants to get relief from sickness.

Many research scientists at the present time have discovered a number of plants in nature that could give healing for man. Some go to the extent of suggesting that if man depends on nature, he could get cured of his illness (Nature cures).

Gandhji took with great delight goat's milk and groundnuts. How many types of fruits are available in nature, which are of medicinal importance! Why should we not eat some of them?

In the natural environment, if one has to live in close contact with nature, he needs to develop self-control. This is very important.

At the present day, nature cures is a slogan brought out by research scientists in that field. Nature is a wonder. Is it not?

QUESTIONS

1. What is meant by growth?
2. What is the difference in growth in animals and plants?
3. Explain growth in living organisms.
4. What are the factors necessary for growth?
5. What controls growth?
6. Growth is the result of metabolism. Give reasons.

VIII. REPRODUCTION

12. METHODS OF REPRODUCTION IN ANIMALS

Each living organism has a limited life span. So they produce young ones like themselves in order to carry on the race. Reproduction is a process

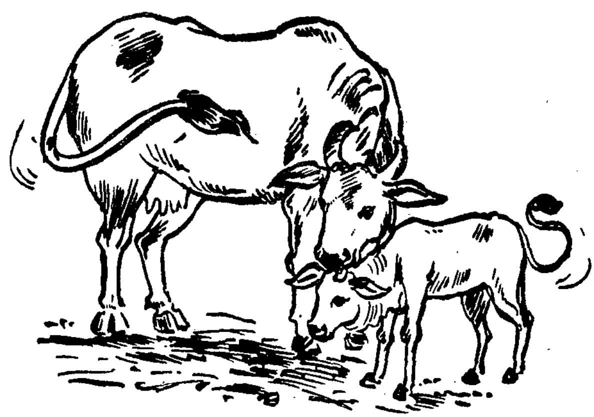


Fig. 143. A mother cow and its calf

wherein an individual produces new individuals of the same kind. Life would disappear unless new individuals are continuously produced. It is essential for the perpetuation of the species.

The calf of a cow is first like the mother cow. The mother looks after its calf carefully and lovingly.

It suckles the young one. Those animals which give birth to young ones and feed them with milk are called mammals.

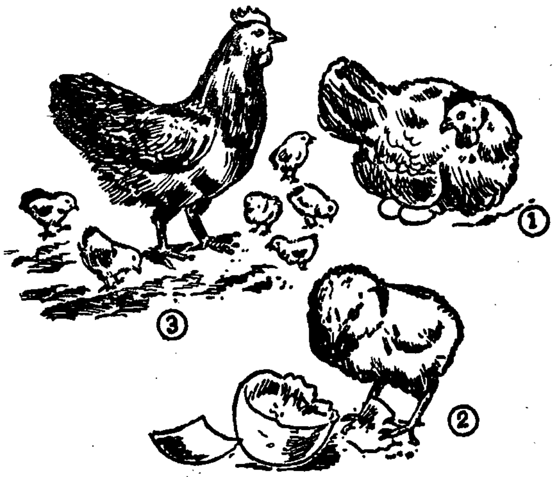


Fig. 144.

1. Brooding hen sitting on eggs
2. A new born chick from the egg
3. Mother hen and its chicks

Some of you may have hens at home. The hen lays eggs and the chicks hatch out of the eggs. You might have seen the bird sitting on the eggs for about 21 days, till the young ones are finally hatched out. This is called **incubation**. The

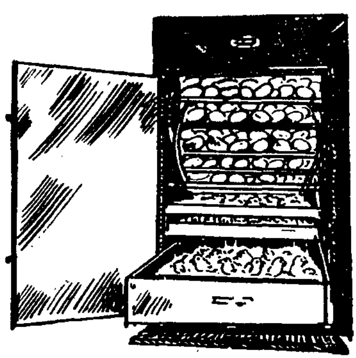


Fig. 145.
Incubator

hen lays eggs, incubates them and raises a new generation of chicks. All birds lay eggs. They take care of their young ones till they can look after themselves. Name a few egg laying animals.

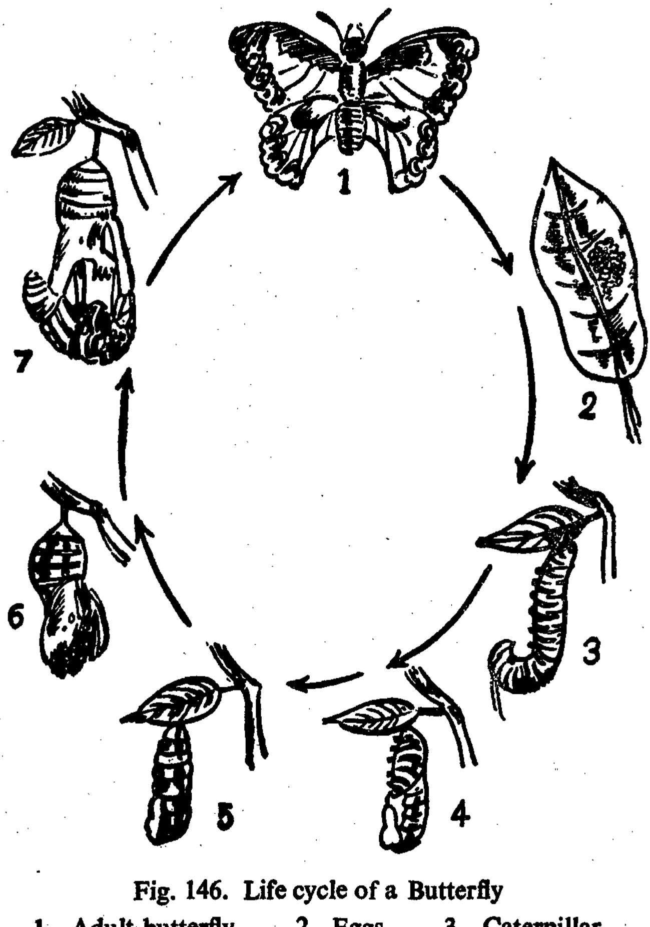


Fig. 146. Life cycle of a Butterfly
1. Adult butterfly 2. Eggs 3. Caterpillar
4, 5, 6, 7 Different stages in pupa

You might have seen tiny eggs and small worms on the undersurface of leaves. Where did they come

from? Take a few worms and put them in a box with a few leaves of the same kind and cover it with a lid having small holes. Observe the worm eating the leaves. After somedays you cannot see them.

Why? Where have they gone? You see the pupa hanging from the leaf. In this stages they stop feeding and enter into a resting stage. Inside the pupa, the animal changes rapidly to develop into an adult. After a few days it hatches out into a beautiful butterfly or moth as the case may be. There are four different stages in the life history of a butterfly- the egg, the larva or caterpillar, the pupa and the adult. The series of changes that take place during the development is called **metamorphosis.**

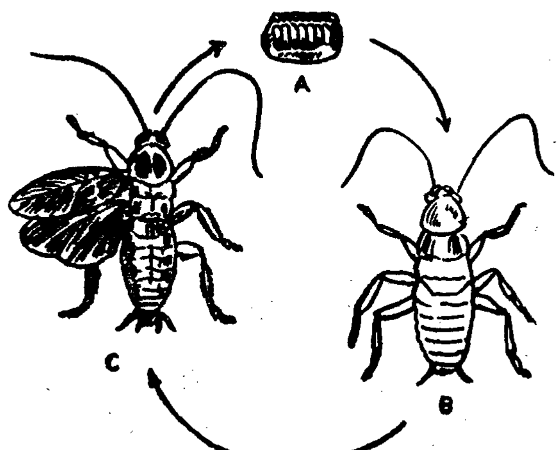


Fig. 147. Life cycle of a cockroach
A. Egg B. Nymph C. Adult cockroach

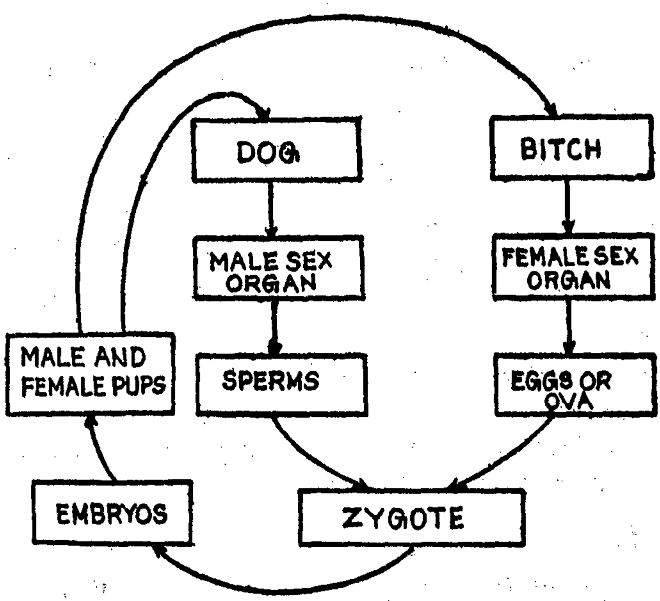
In your home, at nights, especially in the kitchen you might have seen cockroaches. The adult cock-

roach lays eggs and baby cockroaches hatch out. They are called as **nymphs**. They look like adult cockroaches, but they are pale in colour, small in size and without wings. Nymphs do not have reproductive organs.

These nymphs moult about seven times during their growth period and finally become adult cockroaches.



Fig. 148. An organism produces its own kind
A bitch with its puppies



Some of the young ones of insects such as grasshopper, leaf insect etc., look different from the adult.

In the lower animals, such as protozoans, they are able to reproduce asexually (without sex organs). Higher animals reproduce sexually.

Have you seen variations among the puppies produced by a bitch which is a street dog?

Some varieties of dog are very expensive. Those who rear such dogs are careful to mate them with the same variety. They maintain and record the pedigree of the pups.

13. METHODS OF REPRODUCTION IN PLANTS

Look at the life cycle of the mango plant in Fig 149.

Plants produce flowers at a particular season for reproduction. The colours of the flowers and scent are for attracting the insects. Flowers have reproductive or sex organs. The male sex organs are the stamens and the female sex organs are the pistil. Both the sex organs may be found in the same flower or they may be found in separate flowers. If they are present in one and the same flower (e.g. Hibiscus, Lady's finger) the flower is described as bisexual. Unisexual flowers may be male or female (e.g. Papaya, Cocoanut) (Fig 150).

Some plants do not produce flowers (e.g.) algae, fungi and ferns. Reproduction takes place by

different kinds of spores. In some of the higher plants (flowering plants), reproduction may take place without seeds.

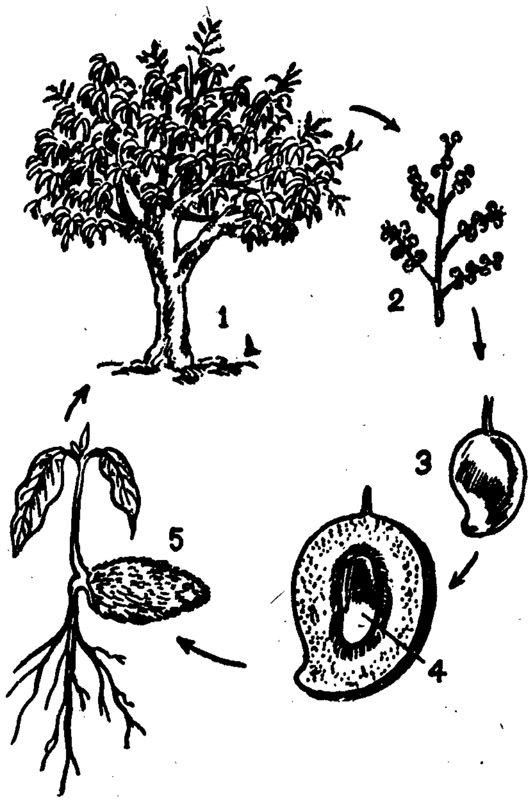


Fig. 149. Life cycle of the mango plant

1. A mango tree 2. Inflorescence (flowers)
3. Fruit 4. Seed 5. Germinating seed

Plant growers use many methods of propagating plants vegetatively. One can grow another plant of the same species by taking a suitable part like stem,

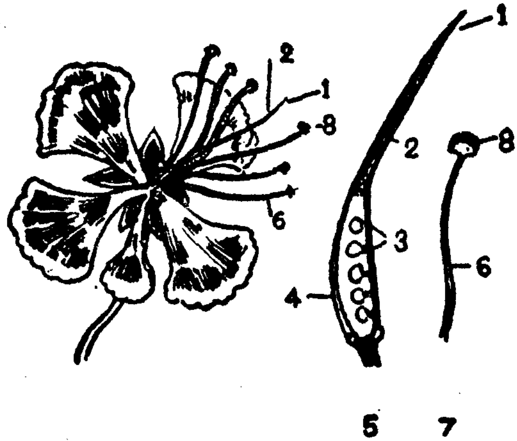


Fig. 150. Essential parts of a flower

1. Stigma 2. Style 3. Ovules 4. Ovary
5. Pistil 6. Filament 7. Stamen 8. Anther

root or leaf of a plant and growing it in the soil. This is vegetative reproduction. Look at the following examples:—

1. Through the stem — Sugarcane, Potato (Fig. 151)
2. Through the root — Sweet potato, Tamarind Lemon, curry leaf.
3. Through the leaf — Scilla, Bryophyllum (Fig. 152)

Man has adopted different methods of propagation.

Layering: In the case of Jasmine, Rose or Lemon, a branch of the plant is bent close to the ground and covered with soft soil and a brick or stone is placed on it (Fig. 153). After a few weeks, it strikes root and produces a new plant which can be separated from the parent plant.

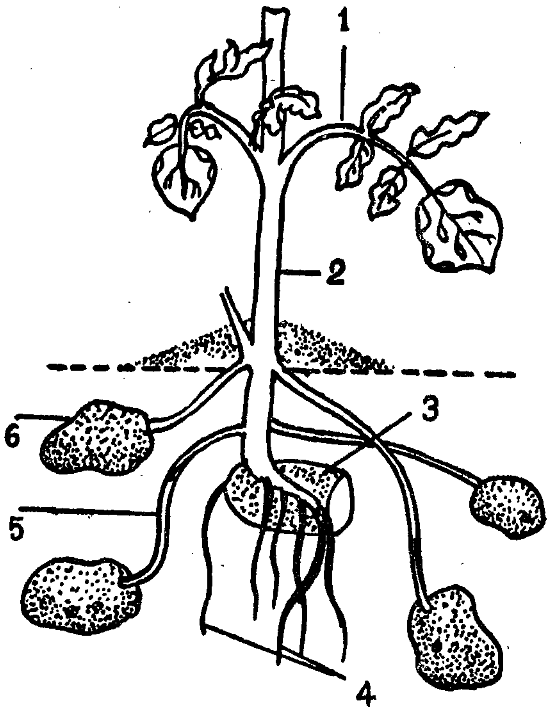


Fig. 151. Parts of a potato plant

1. Petiole (leaf) 2. Stem 3. Seed potato
4. Adventitious roots 5. Underground branch
6. Young tuber

Cutting: Cut a branch from a drumstick tree below a node and plant it in the moist soil. It develops roots at the base and adventitious buds, and becomes an independent plant. The separated portion is called a 'cutting' Try to grow one or two plants from the cuttings of Money plant, Bougainvilla and eroton (Fig. 154).



Fig. 152.
New plants are coming out from the leaf of bryophyllum 1. buds

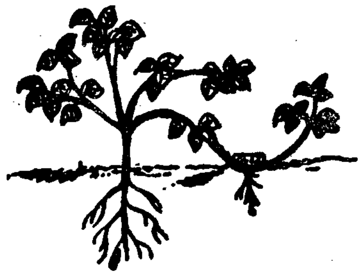


Fig. 153.
Layering

Grafting: A good variety of mango may be grown by grafting a shoot of the desired, good variety or to a shoot of the inferior tree. The two shoots unite and the fruits produced in this new shoot is of the good variety. When plants are obtained by methods of cutting and layering, the characters of the mother

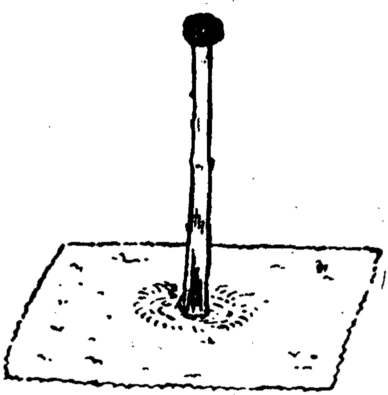


Fig. 154.
Cutting—Drumstick

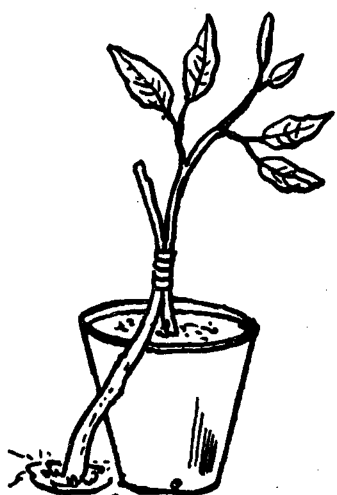


Fig. 155.
Grafting

plant is faithfully reproduced in the daughter plants. But in grafting the quality of the existing variety can be improved. Better and desired varieties of fruits and flowers can be obtained.

QUESTIONS

1. Why do living organisms reproduce?
2. Describe the developmental stages in the life history of the butterfly.
3. Briefly describe how the hen reproduces.
4. How are the young ones of the cockroach different from those of the butterfly?
5. What is sexual reproduction?

   Give three examples for this type as seen in organisms.
6. How does reproduction take place in the ferns?
7. 'Flowering Plants' are found everwhere. 'Why?
8. Describe reproductive methods where-in seeds are involved. Give examples for such plants.
9. Mention the names of two plants where the leaf is responsible for vegetative propagation.

10. What are the benefits by adopting the methods of cutting and layering for vegetative propagation?

For Thought

1. 'When eggs from a poultry farm were hatched, no chicks developed' What could be the possible reason?
2. Sometimes seeds collected from a 4 O' clock plant bearing red flowers grow into plants producing flowers of different colours. Give reasons.
3. How are new species developed in nature?

Exercise

1. Examine a hibiscus flower. Name the various parts.
2. Collect eggs of as many birds as possible and preserve them in your school museum. Take the help of your teacher.
3. Visit a poultry farm and observe how the birds are maintained. Study the incubator also.
4. Collect eggs of butterflies along with the leaves and study the life history.

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